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WHEAT AND FLOUR STUDIES. XI NOTE ON THE EXTRACTION OF PROTEINS FROM WHEAT FLOUR[1]

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Introduction

The official and tentative methods of analysis of the Association of Official Agricultural Chemists (1925) provide for the determination of four protein fractions: (1) the potassium sulfate-soluble protein determined by extracting 6 grams of flour with 100 cc. of 5% potassium sulfate and determining the nitrogen in the filtered extract by the Kjeldahl method. The factor for converting nitrogen to protein is not stated. This fraction is usually considered to be made up of the albumin, globulin, peptides, etc. (2) The alcohol-soluble proteins determined by extracting 4 grams of flour with 100 cc. of 70% alcohol by volume and determining the nitrogen in the filtered extract by the Kjeldahl method. Here again the factor for converting nitrogen to protein is not stated. This fraction is usually considered to consist of gliadin. (3) The remaining nitrogenous material, calculated by deducting the sum of the potassium sulfate-soluble nitrogen and the alcohol-soluble nitrogen from the total nitrogen of the flour and multiplying the difference by 5.7. This fraction is called glutenin. (4) The globulin and albumin, determined by extracting 10 grams of flour with 250 cc. of 1% sodium chloride solution. The nitrogen in an aliquot of the extract is determined by the Kjeldahl method and from the amount of nitrogen so obtained is subtracted the nitrogen not precipitated by phosphotungstic acid, the remainder being called the

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albumin and globulin nitrogen. The factor for converting this nitrogen to protein is not stated. A study of the literature indicates that these separations are not exact, owing to overlapping solubilities, thus they are of value for relative determinations, but are inadequate to ascertain the exact amount of any particular protein in flour.

Teller (1896) found that if flour was extracted with sodium chloride solutions of increasing concentration, less nitrogen was removed the higher the concentration of sodium chloride in the extracting solution. He investigated solutions ranging in concentration from 0.5% to 15% sodium chloride. Some of his data indicate that half of the nitrogen extracted by the sodium chloride solutions was also soluble in 75% alcohol. He believed that 1 per cent sodium chloride solution dissolved a definite amount of gliadin irrespective of the flour. This amount he found to correspond to 0.27% of the flour as nitrogen. He also found that when gluten was extracted with 75% alcohol and 10 cc. of this alcoholic extract was added to 90 cc. of 1% sodium chloride, not all the nitrogenous material was precipitated. He believed that the salt solution removed some gliadin in addition to the edestin, leucosin, and amide nitrogen. Also that 75% alcohol removed the amide compounds in addition to the gliadin.

Chamberlain (1906) found that if flour was extracted first with salt solution and subsequently with alcohol, less protein was removed than if the extraction was made in the reverse order. For example, in a given flour, alcohol extracted 7.47% protein, the subsequent extraction with salt solution removed 0.57% in addition, or a total of 8.04% by the two treatments. The direct extraction of the flour with salt removed 2.18% and subsequent extraction with alcohol removed 5.50%, or a total of 7.68%. He emphasized the error of overlapping solubilities and believed that the small amount of residual potassium sulfate solution decreased the solubility of gliadin in the further extraction of the residue with alcohol.

Olson (1913) showed that considerably smaller amounts of alcohol-soluble nitrogen were obtained from flours which had previously been extracted with 1% sodium chloride as compared with those extracted with alcohol direct. Olson tried to avoid the errors of overlapping solubility in the determination of gliadin by evaporating the alcoholic extract of flour nearly to dryness to remove the alcohol and precipitate the gliadin. The amount of nitrogen in this coagulum was determined and was considered to represent

more nearly the true amount of gliadin nitrogen than did the total protein in the alcoholic extract. Olson's data indicate that only about 69% of the protein extracted from flour by alcohol is gliadin.

Bailey and Blish (1915) took advantage of the fact that the globulin and albumin of flour yield much less ammonia nitrogen when subjected to acid hydrolysis than do the gliadin and glutenin, to determine the composition of the potassium sulfate and the alcoholic extracts of flour. They found, in general, that the potassium sulfate extract contained about 15% of gliadin and the alcoholic extract about 93% of gliadin. According to their work the official method for glutenin would yield too low results, owing to the overlapping solubilities of the potassium sulfate-soluble and alcohol-soluble protein. They also concluded that about three-fourths of the protein which did not coagulate in the procedure used by Olson was gliadin.

Chamberlain (1904) found that in using 1%, 5%, and 10% sodium chloride solutions, less protein was extracted as the concentration increased. He found that about the same amount of protein was extracted with 5% potassium sulfate as with 10% sodium chloride.

Kjeldahl (1896) early showed that the percentage of nitrogen removed from wheat flour by ethyl alcohol depended upon the strength of the alcohol, the greatest amount of nitrogen was removed with a concentration of 55% alcohol. A minimum solubility was found at 20% and the solubility approached zero at 90% alcohol. Others investigated a wide range of alcohol concentration and confirmed his results, namely, Teller (1898), Hoagland (1911), Schleimer (1911), and Olson (1913). Still others who did not investigate so wide a range of alcohol concentration but whose results over the range investigated are in essential agreement with Kjeldahl's investigation, are Snyder (1907), Shutt (1907), Greaves (1911), and Bailey and Blish (1915). Greaves, however, concluded that 74% alcohol gave extracts which were more nearly pure gliadin. Schleimer (1911) extracted two different flours with various concentrations of methyl, ethyl, and propyl alcohol. He found that the maximum quantity of protein was removed in 60% methyl alcohol, 55% ethyl alcohol, and 40% propyl alcohol. The solubility of the protein material decreased on both sides of these optimum concentrations. Tague (1925) determined the solubility of purified gliadin in various concentrations of methyl alcohol. He also obtained maximum solubility in 60% methyl alcohol but the solubil-

ity did not decrease in the lower concentrations of methyl alcohol to the extent found by Schleimer.

Altho Chamberlain (1906) found that hot alcohol removed less protein than cold alcohol, other investigators have not confirmed his results; namely, Nasmith (1904); Greaves (1911); Hoagland (1911); Bailey and Blish (1915). Hoagland (1911) found, however, that the increase in solubility of the gliadin in the hot alcohol did not become apparent to any great extent until a temperature near the boiling point was reached. Greaves (1911) believed that hot alcohol gave results which were abnormally high and that considerable non-gliadin protein was extracted.

Bailey and Blish (1915) found that at room temperature 30% ethyl alcohol extracted 0.89% nitrogen from a particular flour, and that 86.8% of this was gliadin nitrogen. Under the same conditions 50% alcohol extracted 1.27% nitrogen which was 92.9% gliadin nitrogen; 70% alcohol extracted 1.14% nitrogen, 92.6% of which was gliadin nitrogen; while 50% alcohol at a temperature of 83–84° C. extracted 1.53% nitrogen of which 92.4% was gliadin nitrogen.

It has generally been found that the smaller the weight of flour extracted by a given volume of alcohol the higher is the percentage of the total nitrogen dissolved. Mathewson (1908) extracted amounts of flour varying from 1 to 16 grams with 100 cc. of 70% alcohol and found the percentage of protein removed decreased as the amount of flour extracted increased, the difference between extracting 2- and 8-gram portions was only 0.10% protein.

Chamberlain (1906) found that more protein was extracted with the larger ratios of flour to alcohol. Greaves (1911) extracted different amounts of various flours with 70 and 74% alcohol by volume and found, in general, that when smaller amounts of flour in proportion to the alcohol were extracted more protein was removed. The flours varied rather markedly in this regard, however.

Tague (1925) determined the solubility of purified gliadin in solutions of acids and in methyl alcohol and water, and found that the amount of excess gliadin used for a given volume of solvent had a great influence upon the amount dissolved, this being, roughly, in proportion to the excess of solute present. His results also show that proportionally more gliadin went into solution from the smaller amounts of solute than from the larger amounts.

In an effort to eliminate the error in the determination of glutenin, due to overlapping solubilities, Sharp and Gortner (1923)

extracted the same sample of flour first with potassium sulfate and then with alcohol.

Schollenberger, Marshall, and Coleman (1924) attempted to avoid the error due to overlapping solubilities, by multiplying the percentage of protein in the potassium sulfate extract by 0.85 and the percentage of alcohol soluble protein by 0.93. They determined gliadin by refluxing 4 grams of flour for 3 hours with 200 cc. of 50% alcohol by volume. Bailey and Blish (1915) recommended the extraction of the gliadin at 83-84° C. for 3 hours, using pressure flasks.

Experimental

A brief summary of the experimental results given here has previously been published by Sharp (1925).

The procedure described below is a refinement of the method used by Sharp and Gortner (1923). While the A. O. A. C. method for glutenin apparently gives too low results, the method described probably gives values which are too high. The gliadin fraction is probably too low, owing, among other things, to the gliadin dissolved in the potassium sulfate solution. The method is not recommended as accurate for protein fraction determination, but it was rather used as a starting point for attempting to devise an improved method.

I. Proteins soluble in 5 per cent potassium sulphate solution.—Six grams of flour were weighed into a 200-cc. sterilizer bottle and exactly 100 cc. of 5% potassium sulfate solution was added. The bottle was stoppered, shaken thoroly, and then agitated for 1 hour at a moderate speed in a mechanical shaker. The material was centrifuged, all the liquid decanted through a thin paper pulp mat in a Gooch crucible using suction, and the nitrogen was determined in 50 cc. of the filtrate. The nitrogen was converted to protein by the use of the factor 5.7.

II. Alcohol-soluble protein.—The residue after the removal of the 5% potassium sulphate-soluble proteins, as described in I, was saved for this purpose. The filter pulp mat was removed by means of a spatula and returned to the sterilizer bottle, which was then weighed. From this weight was subtracted the weight of the sterilizer bottle alone plus 6 grams, which gave as a result approximately the cubic centimeters of 5 per cent potassium sulphate solution still remaining in the residue, which is here designated as X. To the residue was then added 150 cc. less X cc. of 70% alcohol by weight. About 50 cc. of the alcohol was added and the bottle shaken vigorously at once. If the cake is shaken vigorously

with the alcohol before the alcohol has had time to penetrate the cake as a whole, it can be entirely disintegrated without the formation of lumps. The remainder of the alcohol was then added and the bottle was shaken for 1 hour in a mechanical shaker which inverted the bottle 40 to 50 times a minute. It is probable that a more nearly correct procedure would be to extract with hot alcohol, possibly by boiling under a reflux condenser. The material was centrifuged and the nitrogen was determined in 50 cc. of the supernatant liquid. Filtration was unnecessary. The nitrogen was converted to protein by means of the factor 5.7.

III. Glutenin.—The residue after the removal of the 5% potassium sulphate-soluble protein, I, and alcohol-soluble protein, II, was saved for the glutenin determination. The alcoholic extract was completely decanted from the residue and the bottle and residue were then weighed. From this weight was subtracted the weight of the sterilizer bottle plus 6 grams, which gives approximately the cubic centimeters of alcoholic solution still remaining in the residue, which is here designated by Y. The flour residue was then transferred with water into a Kjeldahl flask. The material adhering to the walls of the sterilizer bottle was loosened by using the finger as a policeman and transferred to the Kjeldahl flask by washing. To the material in the Kjeldahl flask was added 10 cc. of concentrated sulfuric acid, 0.7 gram of mercury, and 10 grams of potassium sulphate. A low flame was used until frothing had subsided, when the flame was increased. Heating was continued until white fumes just began to arise, then an additional 35 cc. of concentrated sulphuric acid was introduced. A low flame was used for heating until frothing had subsided, when the flame was increased. Digestion was continued for 2 hours after clearing. The nitrogen was converted to protein by the use of the factor 5.7. This result is the percentage of protein in the residue. The glutenin was obtained by subtracting from the percentage of protein in the residue the percentage of protein supposedly contributed to the residue by the 5% potassium sulphate and the 70% alcohol extracts which remained after decantation as described in I and II and were designated by X and Y.

Let M represent the percentage of 5% potassium sulphate-soluble protein as obtained in I, and N the percentage of alcohol-soluble protein as obtained in II, then

$$\text{Glutenin} = \text{Protein in residue} - (0.01\ MX + 0.0067\ NY).$$

The glutenin may also be determined by subtracting the sum of the potassium sulfate-soluble nitrogen and the alcohol-soluble

nitrogen, as determined above, from the total nitrogen and multiplying the difference by 5.7.

Some of the results obtained by applying this method to a series of flours are given in Table I. The percentage of the total protein as alcohol soluble protein is much lower than is usually reported for flour and the percentage of glutenin much higher.

TABLE I

RESULTS OBTAINED BY APPLYING THE METHOD OF SUCCESSIVE EXTRACTION TO SEVERAL FLOURS OF DIFFERENT CHARACTER

The results are in terms of percentage of moisture-free flour as protein. Nitrogen was converted to protein by the use of the factor 5.7.

5% K_2SO_4	Alcohol sol. in residue	Residue	Total protein sum	Total protein, direct determination
%	%	%	%	%
2.03	5.71	7.25	14.99	15.07
2.60	5.19	7.11	14.90	14.77
1.96	4.84	6.97	13.77	13.65
2.08	6.41	7.83	16.32	16.47
2.43	6.04	7.85	16.02	16.02
2.10	5.90	7.83	15.83	15.82
2.10	5.99	7.88	15.97	15.96
2.59	5.14	6.66	14.39	14.47
4.30	3.23	6.48	14.01	14.60

An experiment was carried out to compare the effect of temperature upon the quantity of protein removed by ethyl alcohol of various concentrations by shaking 4 grams of flour for 1 hour with 100 cc. of alcohol and by refluxing 4 grams of flour for 1 hour with 100 cc. of alcohol. The data obtained are presented in Table II. This table shows that at every concentration more protein is removed by refluxing. The extracts obtained by refluxing with the lower concentrations of alcohol were turbid. The maximum quantity of protein was removed with a concentration of about 50% alcohol.

TABLE II

PROTEIN (N x 5.7) EXTRACTED FROM 4 GRAMS OF FLOUR BY 100 cc. OF ALCOHOL OF VARIOUS CONCENTRATIONS BY SHAKING FOR 1 HOUR AND BY REFLUXING FOR 1 HOUR

Concentration of alcohol by volume	Protein extracted by shaking	Protein extracted by refluxing
%	%	%
00	2.72	4.38
10	4.49	6.23
20	5.32	6.90
30	6.09	7.92
40	7.21	8.71
50	7.43	9.14
60	7.45	8.82
70	7.34	8.76
80	6.12	7.54
90	3.32	4.77
100	0.17	0.21

The effect of the ratio of weight of flour to volume of alcohol was studied. This experiment was carried out with 50 and 70% alcohol by shaking for 1 hour at room temperature and by boiling under a reflux condenser for 1 hour. The results are given in Table III. Only about 0.2 to 0.3 cc. of the solvent was lost during the refluxing.

TABLE III

QUANTITY OF PROTEIN REMOVED BY EXTRACTING VARIOUS WEIGHTS OF FLOUR WITH 100 CC. OF ALCOHOL (N x 5.7)

Weight of flour	50% alcohol by weight		70% alcohol by weight	
	Shaking	Refluxing	Shaking	Refluxing
Gm.	%	%	%	%
0.5	7.36	8.95	6.70	8.64
1.0	7.42	8.99	6.62	8.01
1.5	7.19	9.08	6.59	8.23
2.0	7.24	8.91	6.60	8.50
3.0	7.30	9.02	6.59	8.90
4.0	7.20	9.15	6.58	9.07
5.0	7.30	9.18	6.57	9.00
6.0	7.33	9.63	6.64	8.83
8.0	7.32	9.77	6.67	9.00
10.0	7.32	9.52	6.64	8.83

The amount of protein removed by different salts of various concentrations was studied and the residues remaining were extracted with 70% alcohol by shaking for 1 hour and by refluxing for 1 hour. The results are given in Table IV. With the exception of $MgCl_2$, more protein was removed in the 5 per cent concentration of the salt than in the 10 per cent concentration. $MgCl_2$ removed much more protein than did the other salts. The more concentrated solution removed the most protein. Refluxing the residues with 70% alcohol removed more protein than did shaking.

TABLE IV

PROTEIN EXTRACTED FROM 6 GRAMS OF FLOUR BY 1 HOUR SHAKING WITH 100 CC. OF SALT SOLUTIONS AND BY 150 CC. OF 70% ALCOHOL USING TWO METHODS OF EXTRACTION—SHAKING AND REFLUXING

Solvent	Protein extracted	Protein extracted from the residue with 70% alcohol		Total protein extracted (sum of the two)	
		Shaking	Refluxing	Shaking	Refluxing
	%	%	%	%	%
H_2O	1.89	5.72	6.23	7.61	8.12
5% K_2SO_4	1.47	4.60	5.54	6.07	7.01
10% K_2SO_4	1.31	5.08	6.02	6.39	7.33
5% KCl	1.90	4.85	5.53	6.75	7.43
10% KCl	1.65	5.09	5.95	6.74	7.60
5% $CuSO_4$	1.75	2.45	4.32	4.20	6.57
10% $CuSO_4$	1.72	2.54	4.52	4.26	6.24
5% $MgSO_4$	1.69	3.91	4.63	5.60	6.32
10% $MgSO_4$	1.51	3.99	5.02	5.50	6.53
5% $MgCl_2$	3.14	4.12	5.01	7.26	8.15
10% $MgCl_2$	3.32	3.75	4.88	7.07	8.20

The behavior of $MgCl_2$ solutions was investigated further. Different quantities of flour were extracted with 100 cc. of 1% and 5% $MgCl_2$ solutions. The results obtained are given in Table V. The greater the ratio of weight of flour to volume of solvent, the more protein removed. Table V also confirms the behavior brought out in Table IV, that $MgCl_2$ removes more protein in high concentration than in low.

TABLE V

PROTEIN IN SUPERNATANT LIQUID RESULTING FROM TREATMENT OF DIFFERENT WEIGHTS OF FLOUR WITH 100 CC. OF $MgCl_2$ SOLUTIONS OF DIFFERENT STRENGTHS

These suspensions were shaken for 1 hour in a mechanical shaker and centrifuged.

Weight of flour taken	Concentration of $MgCl_2$ in extracting solution		
	1%	5%	10%
Grams	%	%	%
½	4.34	4.79	
1	3.78	4.22	
2	3.25	3.76	
4	2.77	3.44	
6	2.57	2.98	3.32

Discussion

This brief investigation records the main results obtained in our investigation of the extraction of wheat flour with different solvents, a brief summary of which has previously been reported by Sharp (1925). It was necessary to discontinue work on this problem and altho our investigation is far from complete, it was thought that the data might be useful to others in continuing the investigation.

We began with the idea of subjecting to critical investigation the method used by Sharp and Gortner (1923) for determining protein fractions. This paper describes a more refined procedure for determining the alcohol-soluble protein extractable from the residue remaining after extracting flour with 5% potassium sulfate. Table II shows that extracting flour with hot alcohol (refluxing) for 1 hour removes more protein than does shaking for 1 hour, no matter what concentration of alcohol is used. Absolute alcohol removes only a small amount of nitrogen. The largest quantity of protein seems to be removed with alcohol of about 50% strength by volume. Altho the data are not presented here, it was found that repeated extraction of the residue with alcohol continued to remove small amounts of nitrogen even after several extractions.

Table III shows the effect of extracting different weights of flour with 50% and 70% alcohol by weight. Results indicate that if extraction is carried out by shaking, the variation in the ratio of

flour to alcohol has no appreciable effect on the amount of protein extracted from this particular flour. Perhaps this flour does not represent the general behavior in this respect, for this conclusion does not agree with the general findings of others. If the extractions are made by refluxing, slightly more protein is removed from the larger weights of flour, especially with 50% alcohol. This point is interesting, for it is just the reverse of what might be expected from the solubility standpoint alone, and indicates a peptizing action on non-gliadin protein material. The extracts obtained after refluxing were slightly turbid.

Table IV shows the quantity of protein removed by extracting flour with different salt solutions. The alcoholic extracts made from the residues contained more nitrogen if the extraction was made by refluxing.

If the additional amount of protein removed by extracting with hot alcohol over that obtained by extracting with cold alcohol is gliadin, then the method used by Sharp and Gortner (1923) for glutenin, as well as the one described here, should be modified to extract with hot alcohol. The literature indicates that the potassium sulfate extract, as described in I, contains some gliadin, and therefore that the alcoholic extract II, even when made with hot alcohol, does not contain all the gliadin. Therefore, methods I and II yield only comparative results.

Blish and Sandstedt (1925) recently described a method for determining glutenin which is based on an entirely new principle. They found that all of the proteins of flour are removed by extracting with an alkaline solution of proper strength, and methyl alcohol. By acidulating such an extract the glutenin is precipitated while the other proteins remain in solution. They found that this method gave the same results for glutenin as the method described by Sharp and Gortner (1923).

The interesting behavior of $MgCl_2$ has been shown independently by Tague (1925), who investigated the amount of purified gliadin dissolved in various salt solutions. He found that $MgCl_2$ solution dissolved large quantities of gliadin and that the solubility of gliadin increased with the concentration of the salt solution. $SrCl_2$ and $BaCl_2$ solutions showed no pronounced solvent powers comparable to $MgCl_2$ solutions.

In our investigation the importance of a definite procedure in regard to temperature, time, and mechanical treatment in making the extracts was recognized. Slightly more consistent checks in our duplicates were obtained when the flour was extracted for 2

hours instead of 1 hour. This statement applies particularly to the extracts made with alcohol by shaking. Refluxing with alcohol for 2 hours was found to extract more protein than refluxing for 1 hour. It was feared that refluxing for too long a period was exerting a peptizing action on some of the non-gliadin protein material.

It was intended to subject the protein obtained in some of these fractions to acid hydrolysis and the ammonia determination as used by Bailey and Blish (1915), but the investigation had to be discontinued.

Except for Table I, this study was carried out with one flour, a bakers' patent milled from Montana spring wheat. Some inconsistencies are apparent when the tables are compared, but the determinations reported in Tables II and IV were made approximately a year and a half before those of Table III.

This investigation should be extended to other flours before definite conclusions are drawn.

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RELATION OF HYDROGEN-ION CONCENTRATION OF DOUGH TO BAKING PROPERTIES[1]

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Since the pioneer work of Jessen-Hansen (1911) came to the attention of chemists interested in milling and baking, the rôle of hydrogen ions in the control of baking practice has been subjected to extensive study. Certain students of this phase of baking chemistry have taken a rather extreme view to the extent that they have contended that the useful baking properties of flour and the treatment to which the doughs should be subjected in fermentation, could be determined by the H-ion concentration of the flour or the dough. An explanation of the exact manner in which the concentration of H ions was manifested in the fermentation and baking of wheat flour doughs has not accompanied all the statements respecting the relative importance of this factor.

Cohn and Henderson (1918) indicated that the physical properties of the gluten proteins were reflected in the characteristics of the dough. Increasing the acidity of the dough was believed to result in an increase in its elasticity. A concentration of H ions equivalent to pH=5± was believed to be optimum and it was stated, "The acidity of the dough at the time of baking seems to be the most important variable factor in bread-making." Henderson, Fenn, and Cohn (1919) presented the results of experiments which indicated that when the H-ion concentration of dough was varied from pH= 3.6 to pH= 7.6, the viscosity passed through a minimum slightly on the acid side of pH=5. Their investigations led them to conclude that the action of acids, bases, and most of the salts that were studied is favorable chiefly through their effect upon viscosity.

Bailey and LeVesconte (1924) found that when the H-ion concentration of a dough (original pH=5.8) was varied, its extensibility as measured with the Chopin extensimeter passed through a maximum at pH=6.1±.

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The earlier studies of the gluten proteins seemingly indicated that their iso-electric point would be in the range of 5±. Recently Eto (1924), and Tague (1925a, 1925b) reported the iso-electric point of gliadin to be in the range pH=6.5±. Tague (1925a) places the iso-electric point of wheat glutenin at pH=6.8 to 7.0, which conclusion is seemingly supported in a measure by the observations of Sharp and Gortner (1923) on the effect of H-ion concentration upon the viscosity of flour suspensions. The data presented by Sharp and Gortner show a low and comparatively uniform viscosity between pH=5.5± and pH=8.5±, the median point of this being about pH=7.

Hoffman and Gortner (1925, p. 352-356) discuss the question of the iso-electric points of proteins. They point out that there are theoretically two types of iso-electric points: (1) the "adsorption iso-electric point" where surface forces are at a minimum and adsorption of neither H^+ or OH^- takes place, and (2) the "chemical iso-electric point" which is determined by the ionization of acidic or basic groups within the protein molecule. From their calculations they find the "adsorption" iso-electric point of gliadin to be at pH=6.97, 7.16 and 7.60 using three independent sets of data. Concerning the "chemical iso-electric point" they state, "Here the 'iso-electric point' is not definite, i. e., a definite pH value, covers a wide 'iso-electric range'." In the case of gliadin this "range" lies between about pH=5.0 to pH=9.0. In other words, gliadin shows no "buffer value" between these ranges in pH. If it is permissible to take the median point on such an iso-electric range as the iso-electric "point", then the "chemical iso-electric point" and the "adsorption iso-electric point" of gliadin would be practically identical at or near pH=7.0.

These observations do not support a contention that an increase in the H-ion concentration of dough incidental to fermentation would result in an improvement of the physical properties of the dough as a whole and more particularly of the gluten proteins. In fact, the evidence available leads to the opposite conclusion.

The activity of enzymes may, however, be accelerated by an increase in the H-ion concentration above that found in freshly mixed dough. Diastatic activity was observed by Rumsey to pass through a maximum at pH=4.7±. In the instance of a flour with which Rumsey worked, the relative diastatic activity approximately doubled when the H-ion concentration was increased from pH=5.9 to pH=5.2.

Sörensen (1924) reviewed Rumsey's paper and suggested that in addition to determining the diastatic activity of a flour at its original H-ion concentration, it would be well to vary the degree of acidity and plot the change in diastatic activity through the range of H-ion concentration that was covered by such tests.

With the 17 flours[2] which we studied, this suggestion of Sörensen's was followed to the extent that the diastatic activity of all the flours was determined at both the initial H-ion concentration and at an H-ion concentration equivalent to pH=5. Both sets of results are recorded in Table I, the first value under the symbol M_0, the diastatic activity at pH=5 under the symbol M_a. The H-ion concentration of the initial or unacidulated flour suspension is also shown in this table. The same data are recorded graphically in the figure.

TABLE I

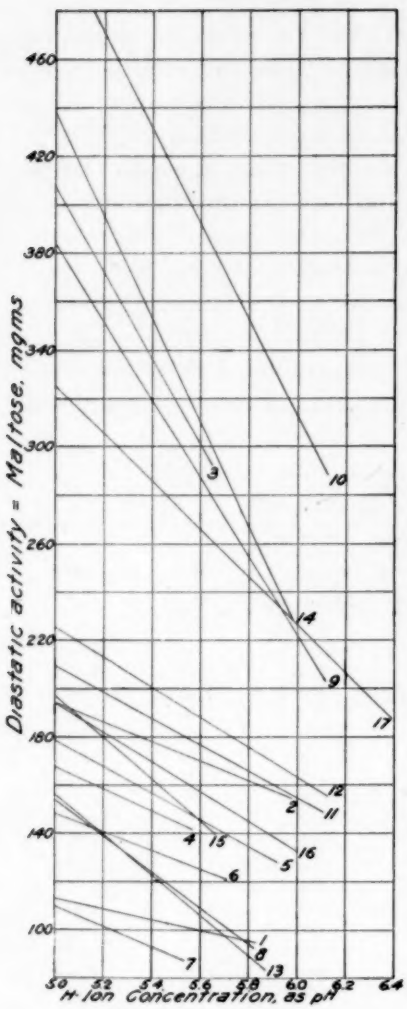
DIASTATIC ACTIVITY OF THE 17 FLOURS

Lab. No.	Maltose produced per 10 g. flour (M_0)	H-ion concentration	0.1 N lactic acid to bring 10 g. flour to pH 5.0	Maltose produced per 10 g. flour at pH 5.0 (M_a)	$\frac{M_a}{M_0}$	$\frac{d\,M^*}{d\,pH}$
	mgm.	pH	cc.	mgm.		
1	94.8	5.83	1.3	114.8	1.21	2.410
2	154.0	5.98	1.5	194.4	1.26	4.122
3	292.4	5.65	1.1	407.2	1.39	17.662
4	141.6	5.57	1.0	167.2	1.18	4.491
5	128.0	5.92	1.6	178.4	1.39	5.072
6	120.8	5.71	1.2	148.4	1.23	3.886
7	88.0	5.52	0.8	112.0	1.27	4.615
8	92.4	5.82	1.2	154.4	1.67	7.544
9	202.8	6.12	2.1	383.2	1.89	16.107
10	288.0	6.13	2.2	511.6	1.78	19.786
11	150.4	6.11	2.0	208.8	1.39	5.261
12	155.2	6.13	2.0	224.8	1.45	6.159
13	93.6	5.87	1.2	156.0	1.67	7.310
14	228.0	5.98	1.9	438.0	1.92	21.428
15	140.4	5.66	0.9	197.2	1.41	8.606
16	132.8	6.00	1.8	196.0	1.48	6.320
17	187.6	6.39	3.3	325.2	1.73	9.899

*dM = change in diastatic activity, d pH = change in H-ion concentration expressed as pH.

In every instance the diastatic activity was increased substantially by the addition of sufficient lactic acid to bring the H-ion content to the equivalent of pH=5. The relative rate of increase in diastatic activity with increasing H-ion concentration may be discerned by scanning the graph. Additional determinations might profitably be made between the limits of H-ion concentration involved in these studies. Thus, it is possible that such determinations would indicate that the graphs should not be drawn as

2 These flours were described in the earlier paper (Cereal Chem. 4: 230-247).



straight lines altho the data available from the work of Rumsey (1922) and reported by Sörensen (1924) indicate that the curve approaches a straight line when diastatic activity is determined through the range of pH involved in these studies. It accordingly appeared that a useful measure of the effect of increasing H-ion concentration would be available if the data were plotted in the manner in which they appear in the figure.

The rate of change in diastatic activity with the change in H-ion concentration can be expressed as the tangent of the angle which these plots form with the axis of abscissas in the data recorded in the figure. This tangent is recorded in column 7 of Table I. The conclusion reached by scanning these data and the plots in the figure is that the rate of increase in diastatic activity with changing H-ion concentration is greatest in flours with a high initial diastatic activity. To test this assumption, the 17 flours in the series were classified in three groups, namely,

1. Flours with a diastatic activity of less than 150 at pH=5.5.
2. Flours with a diastatic activity between 150 and 300 at pH=5.5.
3. Flours with a diastatic activity over 300 at pH=5.5.

On this basis of classification there are 6 flours in the first group—Nos. 1, 4, 6, 7, 8, and 13; 7 flours in the second group—Nos. 2, 5, 11, 12, 15, 16, and 17; and 4 flours in the third group—Nos. 3, 9, 10, and 14. The average of the tangents which the plot forms with the axis of abscissas in the three groups in the order named is (1) 5.14, (2) 6.49, (3) 18.75.

Since the H-ion concentration of dough increases in consequence of fermentation, as shown by Bailey and Sherwood (1923), and Johnson (1925), an accelerated rate of saccharogenesis should be encountered in the later stages of dough fermentation just when additional sugars are most needed. In the light of these data and the computations based thereon it appears that flours which are initially low in diastatic activity will respond the least to the increased H-ion concentration that is the normal consequence of yeast fermentation, which fact may explain in a measure the inferior baking qualities of such flours.

While the addition of small quantities of acid to dough tends to increase diastatic activity, the addition of alkali tends to diminish the activity of the diastases. Such a reduction in this property of dough must therefore be compensated for if the baking properties of an alkaline dough are to be studied. In order to ascertain the extent of decrease in diastatic activity that would be encountered upon the addition of alkali, a hard spring wheat straight-grade flour was divided into several portions, to each of which was added a different quantity of sodium hydroxide solution. The resulting H-ion concentration is recorded in Table II, together with the diastatic activity. The original diastatic activity was normal for flours of this type, but diminished at an appreciable rate as the amount of alkali was increased, reaching a very low level at pH=8.5.

This preliminary experiment indicated that an appreciable quantity of highly diastatic material must be added to a dough that is rendered alkaline if the diastatic activity is to be maintained at approximately a normal level.

TABLE II
DIASTATIC ACTIVITY OF FLOUR ALTERED BY THE ADDITION OF ALKALI

Quantity of 0.1 N NaOH per 10 grams of flour	H−ion concentration	Diastatic activity as maltose per 10 grams of flour
cc.	pH	mgm.
0.0	5.9	206
0.8	6.5	105
1.7	7.0	72
2.2	7.5	28
2.8	8.0	23
3.6	8.5	12

One of the most acceptable sources of diastase to be used in supplementing the natural diastase of ordinary flour is flour milled from wheat that has been germinated or sprouted under controlled conditions. Sherwood and Bailey (1926) found that the sprouted wheat flour produced from wheat which had been wetted and al-

lowed to germinate for three days at 22° ± C. with a continuous removal of the carbon dioxide of respiration was useful in this connection. Such wheat, on drying at moderate temperatures, could be milled into flour with a high diastatic activity, but with such a low proteolytic action as to be without effect upon the solubility and properties of the flour proteins when mixed with a normal flour in amounts ranging around 2% to 3% or more.

A sprouted wheat flour of this type was prepared, and varying amounts were added to a flour with a low initial diastatic activity. The first addition of 2% sprouted wheat flour very substantially increased diastatic activity. The next addition of 2%, or 4% in all, further increased the diastatic activity, but quantities in excess of 5% had little additional influence. Since other factors might come into play if more than 5% of sprouted wheat flour was added, it was deemed inadvisable to use more than the 5% of such material in building up the diastatic activity of flours originally deficient in that property.

At this stage of the investigation it appeared desirable to ascertain whether or not all the flours in the series that were known to be deficient in diastase could be successfully brought into the range of diastatic activity which is regarded as desirable in a good baking flour, namely 200± units. Ten of the 17 flours exhibited a diastatic activity of 155 units or less. After some preliminary experimentation, the dosage required to effect an increase to 200 units without exceeding 5% of sprouted wheat flour, was computed. With flours Nos. 1 and 13, milled from Pacific Coast white wheat and Ohio red winter wheat, respectively, the 5% of sprouted wheat flour failed to increase the diastatic activity to the level which was desirable. Flour No. 8, milled from Indiana soft winter wheat, was likewise somewhat below the 200 units in diastatic activity after the addition of 5% of sprouted wheat flour; while flour No. 7, milled from Indiana and Ohio soft winter wheat, approached closely to the minimum of 200 units. The four flours mentioned all had an initial diastatic activity of less than 100 units. The six flours having a diastatic activity ranging between 128 and 155 units had their diastatic activity increased to 200 units or more through the addition of 5% or less of the sprouted wheat flour.

These observations indicats that it was not always possible conveniently to increase the diastatic activity to the desired level through the use of sprouted wheat flour, altho this apparently can be accomplished if the initial diastatic activity is equivalent to 125 units or more.

In all instances noted in Table III except one (flour No. 15), the addition of sprouted wheat flour improved the loaf volume or crumb texture or both. With these experiences in mind, baking trials were laid out which involved the addition of alkali to the dough, together with a sufficient quantity of sprouted wheat flour to maintain a reasonably high level of diastatic activity in the dough. The quantity of 0.1 normal sodium hydroxide solution added to each of these doughs made with 325 grams of flour, is recorded in the first column of Table IV. Sprouted wheat flour was added to each of the doughs except the control, which was mixed without the addition of alkali. In the first three instances 5% of this sprouted wheat flour was used. In the fifth dough, which contained the same amount of alkali as dough No. 4, 10% of sprouted wheat flour was used, and the same quantity was included in the mixture to which the largest quantity of alkali was added.

TABLE III
EFFECT OF SPROUTED WHEAT FLOUR ON DIASTATIC ACTIVITY AND BAKING PROPERTIES OF FLOUR LOW IN DIASTATIC ACTIVITY

Lab. No.	Sprouted wheat flour	Diastatic activity as maltose per 10 g. flour	Fermentation period	Loaf volume	Crumb texture score
	%	mgm.	min.	cc.	
1	0.0	94	109	1810	90
1	5.0	135	106	1835	90
2	0.0	154	141	1990	97
2	2.3	199	137	2090	97
4	0.0	142	149	2150	97
4	3.3	233	145	2240	98
5	0.0	128	141	2170	99
5	5.0	225	141	2270	100
7	0.0	88	119	1990	97
7	5.0	188	113	2270	99
8	0.0	92	111	1970	96
8	5.0	172	108	2030	98
11	0.0	150	153	1980	97
11	2.5	207	148	2020	97
12	0.0	155	128	2150	98
12	2.4	218	123	2180	98
13	0.0	94	112	2020	97
13	5.0	154	109	2070	98
15	0.0	140	144	2200	99
15	5.0	228	141	2100	99

The H-ion concentration (as pH) of the doughs when freshly mixed and of the baked bread, appear in Columns 2 and 3 of Table IV. The loaf volume in cubic centimeters and the texture score assigned the bread indicate that the best bread can be made from doughs in which the H-ion concentration has been decreased rather than increased, providing diastatic activity and fermentation rate

are maintained at approximately a normal level. The optimum H-ion concentration (with constant diastatic activity) is not disclosed by these preliminary studies, but investigations are now under way which may indicate the approximate range through which this optimum will be encountered.

These observations should not be taken to imply that superior bread can be produced in a practical way if an alkali is added to an ordinary bread dough. Such a practice would undoubtedly result in inferior bread, owing to the inhibited diastatic activity. However, these observations seem to support the conclusion that the usual increase in H-ion concentration which occurs in the fermentation of bread dough is not advantageous from the standpoint of its influence upon the physical properties of the dough or of the gluten proteins, and that, on the contrary, a disadvantageous result accompanies the increase in acidity when measured in terms of dough properties. The data recorded in this connection add further emphasis to the important rôle of diastase in fermentation and baking, and suggest that a failure to provide for adequate sugar production, or saccharogenesis, because of either an inadequate concentration of diastase in the flour or a failure to control the acidity, will result in bread inferior to that which might result from the proper treatment of such flour.

TABLE IV

H-ION CONCENTRATION OF DOUGH AND BREAD AFTER ADDITION OF VARYING QUANTITIES OF ALKALI, AND BAKING QUALITY OF THE DOUGHS

Quantity of 0.1 N NaOH used for 325 g. flour	Hydrogen-ion concentration		Sprouted wheat flour	Loaf volume	Texture score
	Of dough pH	Of bread pH			
cc.			%	cc.	
0	5.9	5.5	0	2130	98
26	6.5	6.0	5	2130	99
55	7.0	6.2	5	2010	100
71	7.5	6.4	5	2220	99
71	7.5	6.4	10	2230	97
91	8.0	6.6	10	2240	97

Summary

Gluten proteins appear to have an iso-electric point slightly on the alkaline side of the H-ion concentration ordinarily encountered in doughs made with untreated patent or high grade flour. Extensibility of doughs passed through a maximum on the alkaline side of the original H-ion concentration of simple flour-water doughs. It accordingly appeared that the extensibility and gas-retaining capacity of doughs might be improved by the addition of alkali to the dough.

Diastatic activity in a dough is inhibited by the addition of alkali and it becomes necessary to compensate for the reduced diastatic activity in dough by the addition of material containing active diastases, when baking properties of an alkaline dough are determined.

Alkaline dough containing added diastase was converted into bread that was superior to that produced from controlled doughs to which no alkali had been added.

Rate of change in diastatic activity with increasing H-ion concentration was not uniform in all flours. Flours with high initial diastatic activity exhibit the greatest rate of increase in that property when acids are added.

These observations do not imply that alkali should be added to doughs in the ordinary processes of bread making. They indicate, however, that the increase in H-ion concentration normally occurring in dough fermentation results in improved bread, primarily because of the accelerated activity of the enzymes and particularly of the diastase, rather than because of an improvement in the physical properties of the dough.

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VALUE OF EXPERIMENTAL MILLING TEST

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(Read at the Convention June 3, 1927)

C. H. Bailey, in his introduction to "The Chemistry of Wheat Flour," outlines that,

"Properties of flour must be considered in relation to: (a) the raw material from which it is manufactured, or wheat; (b) the process of manufacture, or milling; (c) its adaptability to the principal use to which flour is put, or baking."

Experimental milling is of value in each of these three relations. It ascertains the nature of wheat, foretells its utility in terms of yield and flour quality as to color and analytical data, and provides flour from which baking characteristics may be ascertained. Such information is adaptable to guiding wheat purchases and wheat blending for the continued maintenance of similar characteristics in the different mill products. Strictly speaking, a flour produced with the experimental mill is not identical with the comparative grade produced in commercial milling. The latter process comprises purification, not practiced in experimental milling, and the reductions and separations are more numerous and more gradual. Further, when in continuous operation the temperatures maintained during the cycle of commercial milling are more uniform. For these reasons experimental milling cannot quite duplicate, it can merely approximate, the results of commercial milling, but the results are strictly comparable. The trained operator must co-relate his findings.

As an example of actual operations, the results obtained from a group of 214 wheats, all grown in Kansas and varying in protein content from 10 to 16 per cent gave, upon tabulation, the following grand total averages:

	%
Protein content of wheat	12.85
Protein content of flour	11.30
Ash of flour	0.41
Yield	4.29
Per cent of patent flour	80.43
Per cent of clear flour	19.57

These 214 samples are representative of carload deliveries of about 320,000 bushels of wheat. Each sample was separately ground and specifically allocated when blending for mill mixture. It is presumed that it will be granted that a 0.41% ash and 11.30% protein extraction from a 12.84% protein wheat is, in an 80% patent flour, comparable to commercial mill practice. The yield of 4:29 in terms of clean wheat is also comparable and will speak for itself. Mill blends made on a basis of ascertainments from experimental milling tests, verify this. Analytical data and baking results of the experimentally milled flour closely coincide with those of commercial flour from such blends. The ash tendency is slightly lower, the color is somewhat superior, and the diastatic activity is tangibly higher on commercially milled flour in comparison with experimentally milled flour from the same wheat.

As is our practice, each of the 214 flours was baked by the Werner differential method. While this method is very satisfactory for normal practice, it is particularly well adapted for use with samples available from the experimental mill, because only a small amount of flour is required for each test baking and, if required, a series of duplicate bakings may be made from the quantity of flour produced from one experimental milling. The averages follow:

	cc.
Unbleached and untreated, volume per 100 grams flour	433
Stimulated, volume per 100 grams flour	483
Difference per 100 grams flour	50

It is deemed unnecessary to discuss in detail flour bleaching and the effect of the various methods used. It is merely noted that the average difference in volume of 50 cubic centimeters per 100 grams of flour is, as it should be, somewhat better than the results obtained from the best use of either chlorine or nitrogen trichloride. We have available a miniature bleaching apparatus which gives results closely approximating the use in commercial practice of the same method. We have deemed it desirable to employ this

method of bleaching on our experimentally milled flour samples in order to approach more closely the baking characteristics of commercially milled flour from the same wheat, bleached by the same method. In the laboratory we frequently use in lieu of bleaching 0.5% of Arkady in terms of flour, and also use the same substance for the differential test. Werner, who suggested this differential test, prefers the use of 1 milligram, in other words, 0.001% of potassium bromate. We both find that the quantitative addition of a stimulating substance can, at least in the laboratory, be better controlled gravimetrically than volumetrically.

Altho somewhat foreign to the main subject, it is deemed of sufficient interest to describe in a limited way this differential test which we have found most helpful not only in interpreting the characteristics of experimentally milled flours but also for ascertaining the comparative baking characteristics of commercial flours. We have practiced the fixed method of experimental baking for six years and have baked in duplicate to secure that sense of assurance which only duplicate work gives. In making the differential test, we merely add to one of the doughs either 0.5% of Arkady, or 0.001% of potassium bromate, and handle the two doughs identically as when baking for duplicates. Time, temperature, mixing, punching, molding, proofing, and baking remain the same. As a result of the addition of such stimulating material (we have all known for many years that all these materials either are oxidizers or function, in part at least, as oxidizers), differences are obtained which are expressed as loaf volume external appearance, crust color, and such crumb characteristics as grain, texture, sheen, and color.

Werner has found (and we have verified his observations) that with any flour, whether milled experimentally or commercially, a positive reaction in terms of volume with minimum detriment to crust color and grain structure, is indicative of baking quality as conceived by the commercial baker. The degree coincides almost directly with the numerical difference in expansion and with the drastically apparent changes in crust color. The response of flour to this differential test varies greatly with wheat, milling method, nature and degree of extraction, and type and quantity of bleaching practiced. We find it convenient to think and speak of flour characteristics in terms of positive, neutral, and negative reaction. We find that flours from the experimental mill giving positive reaction are the product of wheats desirable for the commercial milling of so-called bread flours. Such wheats must constitute a

tangible proportion of all wheat blends of the commercial miller, producing high quality bread flour. We say tangible proportion, as we have frequently found as the result of experimental milling and baking, that wheats and resultant flours complement each other. We have even found in the blending of two flours from different wheats, one having a negative and the other a positive reaction, that the blend will have better positive reaction than either of its component flours. The adoption of the differential test has materially widened the scope of application of the experimental milling test and has made that test of inestimable value for mill control work especially.

The interpretation of the experimental baking test has been discussed at length and even more may be said respecting the interpretation of the experimental milling test. Here, as well as in the baking test, experience, technic, and a conception of commercial practice cannot be expressed arithmetically or geometrically. We will therefore merely describe the basis of the particular procedure which we practice and outline the results. We prefer to mill 1200 grams of the cleaned wheat. Our experimental mills are ordinary Allis experimental reduction units, consisting of one pair each of corrugated and smooth rolls. Separations are made on gyrating plansifters, the bolting cloths of which are not changed. The patent flour is finished or dressed on II xx cloth, and is alone used for qualitative ascertainment; the clear being as a rule merely noted quantitatively. There is some objection to this procedure of splitting the stream, but the stock representing the clear and low grade is so limited in quantity that it is difficult to handle it without considerable loss. Maintenance and adjustment of this mechanical unit are well within the skill of the operative miller or the chemist if the latter cares to give it thought and time. The grinding operation need not be discussed. The two pairs of rolls are used repeatedly and sequentially to bring about the results tabulated in connection with the 214 samples mentioned. I need only emphasize that as nearly as possible conditions of temperature, relative humidity, roll adjustment, and separations are maintained uniform for all samples. The wheat is cleaned on a miniature separator and scourer and the weight per bushel is noted before and after cleaning. Moisture is ascertained on the rough ground sample by the routine air-oven method, 130° for one hour, thereby bringing moisture ascertainment in wheat to conformity with the method now official for flour. We find from experience approximately 16% total moisture best for average

hard winter wheat when milled in the cycle of experimental milling. This is approximately 1% more than is demanded by the large industrial units. Such minor variations in tempering as are at times found necessary in the large mill are of equal importance in the small mill. As stated, however, 16% uniformly held will give (at least to us) most satisfactory and most comparable results. In any event, variations in actual tempering practice are slight and of minor importance, the major requirement being uniform physical condition of the wheat in terms of moisture. To accomplish this is our aim, and no difficulty is experienced in tempering wheats varying as much as 4% in moisture content with sufficient precision to bring the flour moisture practically within the limits of the error of determination. A covered tin can is used for tempering, into which is placed the wheat to be ground and the needed amount of water to correct the moisture to the 16% total desired. This is allowed to stand for 18 hours with occasional agitation. We make six corrugated and eight smooth roll reductions. All flour passing through the II xx cloth is considered to be "patent" and averages in the above 214 samples, 80.43% of the total extraction. I repeat that in color, dress, ash, and protein extraction it is comparable with an 80% patent produced in commercial milling from the same wheat or wheat blend. This, however, is not true of the clear, which can be produced to better quality on the large mill.

Summary

The experimental milling test is valuable for separating from wheat samples a definite amount of flour which closely resembles in terms of routine analytical factors and baking characteristics the product of commercial milling of approximately the same percentage from the same wheat or blend.

Tests made on this definite amount of flour allow close assumptions as to the anticipated characteristic nature of different extractions when obtained in commercial milling from the same wheat or blend.

The experimental milling test gives precise and concise information which cannot otherwise be obtained.

It foretells in close approximation milling quality, yield of wheat, and characteristics of flour from it. If practiced in connection with experimental baking it will foretell the utility of the flour in terms of value for specific purposes.

WHAT PROGRESS ARE WE MAKING AS CEREAL CHEMISTS[1]

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(Read at the Convention, May 30, 1927)

Just as the business man periodically takes off a balance sheet, so it behooves us as chemists to pause occasionally and take stock of our accomplishments. Are these accomplishments sufficient to justify the investment in time and money which they represent? Do they merit continued confidence in the workers in this field?

In measuring contemporary progress it is undesirable to restrict the period to a few months or even years. It is very difficult, in fact, to ascertain at times just when a particular task was undertaken or completed. In organizing this discussion, I have accordingly chosen to deal with the last decade—a sufficient period of time to facilitate contrasting the developments of this period with previous accomplishments in the same field.

Cereal chemistry may be considered to involve several phases of applied biochemistry. Like biochemistry in general, it has only recently emerged as a special subdivision of the chemical sciences. In order that we may more readily discern the differences between current methods and those which preceded them, a classification in chronological sequence of the development of cereal chemistry should be traced.

The earliest period involved the application of crude methods, which merely served to establish qualitatively the existence in cereal products of a variety of unlike substances. Beccari, in 1728, called attention to the fact that wheat flour can be separated into two portions which he characterized as being "vegetable" and "animal" in character. In the second period, methods of quantitative analysis were developed, which facilitated the determination of the ultimate composition of the materials in which the cereal chemist has an interest. Advances in organic chemistry marked the third major period. During this time the chemical constitution of many of the constituents recognized in cereals and cereal products was established with a fair measure of precision. The gluten proteins were hydrolyzed and many of the components of

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the hydrolysate were identified, or even quantitatively determined. It naturally followed that an effort to account for variations in the properties of wheat flour on the basis of the percentage of the organic constituents was the distinguishing activity of this period.

Toward the close of this period the attention of biochemists was attracted to the activity of certain catalysts of biological origin, which they characterized collectively as enzymes. It came to be recognized that the constitution and properties of the organic constituents of biological materials would undergo modification under suitable conditions in consequence of the presence of enzymes. This was indeed an important development, since it served to advance cereal chemistry from the descriptive to the dynamic stage. We began to concern ourselves more and more with progressive changes rather than with the initial composition of the materials with which we had occasion to deal.

Finally, the field of cereal chemistry has felt the effect of certain physico-chemical developments. Numerous applications of physical chemistry have been made, not alone to our laboratory methods but even more prominently in our processes of thought. This has further facilitated the consideration of the dynamics of the processes that are set in motion when cereal products are converted into human food.

Prominent among the physico-chemical methods that have been applied to the study of the properties of wheat flours are (a) electrolytic resistance, (b) hydrogen-ion concentration, (c) viscosity, and (d) plasticity. While it would be incorrect to assert that the results of these physico-chemical measurements have been definitely correlated with those properties of flour which determine its market value and baking qualities, we may concede that the efforts made to establish these correlations have probably contributed more to the progress of the current period than all other developments of the period combined.

In order to ascertain the views of cereal chemists respecting the progress that has been made in the last decade, the question was directed to a score of representative chemists in America and abroad. The replies received are interesting and significant. I wish to express my indebtedness to all of the chemists who replied to my inquiries. The statements made in these communications can be divided roughly into two classes; (1) those which rather pessimistically concluded that the past decade had been devoid of important accomplishments, and (2), those which indicated a definite progress in the direction of the standardization of methods.

A few replies went beyond these limits and mentioned other accomplishments, but in general these were distinctly in the minority.

I am inclined to feel that the past decade has witnessed substantial progress in several particulars. One outstanding feature of the period has been the splendid spirit of co-operation manifested by the cereal chemists of America. This spirit has registered in terms of a substantial progress in the standardization of methods, for it must be recognized that such standardization is impossible without co-operative effort. The same spirit has likewise facilitated the development of publications, in which appear, as a permanent record, the results of observation and research in this field of science.

The multifarious activities of the cereal chemist have had an indirect effect in a direction which was possibly not anticipated. I have reference to the educational forces which have been set in motion and which are identified in terms of the increasing attention given to the composition of wheat in the merchandizing of that commodity. If any one had suggested ten years ago that a chemist's certificate might have the effect of appreciating the value of wheat to the extent of fifteen or twenty cents a bushel, he would have been cried down as a fanatic. Yet this has happened, and is happening repeatedly in the hard wheat markets of America, particularly in seasons when the crops are distinguished by a low average protein content.

In the baking laboratory as well as in the chemical laboratory, the methods in vogue are more precise than at the beginning of the current decade. Physical devices which are designed definitely and uniformly to control the temperature of the cabinets and ovens are becoming increasingly common in the baking laboratory. The continued effort to standardize and unify the methods of test baking is evidence of the serious consideration being given to this difficult undertaking.

Coincidentally with the progress made in this phase of biochemistry has occurred substantial progress in certain related fields. For example, it is evident that a more definite control of the processes of yeast manufacture has resulted in the production of a more uniform baker's compressed yeast than was formerly available. This alone has done much to ease the task of the test baker, since it ensures the desired uniformity in the reagent which was formerly the most variable.

During the last five years a notable advance has been made in the critical examination of data resulting from the tests and analy-

ses of wheat products. We are coming not only to appreciate, but actually to measure, the variability in a series of replicate tests of the same materials. This, in turn, is leading toward the development of procedures which are likely to afford correlations between the measurements of the laboratory technician and the properties of the cereal products, as the latter become evident when used in industrial processes. There has undoubtedly been much loose reasoning from meager data in the past, but this is rapidly giving place to the refined calculations of the statistician. Certain of the earlier conclusions are found to be unsupported by the results of a statistical analysis of the data on which they were based, and such conclusions are being gradually laid aside. The result is a better definition of the state of our knowledge and of the limitations that are imposed in interpreting the data from the laboratory.

AN AUTOMATIC PROOF BOX

C. G. HARREL

Bakeries Service Corporation, New York City

(Read at the Convention, May 31, 1927)

In some laboratory bake shops there are frequently as many as fifty or more doughs to be baked. This means that the person in charge devotes a great deal of time to watching them so that they will all have the same proof. In laboratories whose "bake" is a very few loaves each day the baker or chemist usually has other duties that require attention while the doughs are proofing. The result in either case is that much time is wasted in watching the proof. Often the dough is over-proofed, introducing a variable in the final baking results.

There are two methods of proofing doughs: (1) Proofing to a definite time; (2) proofing to the same height in the pan. When pans of the same dimensions are used, if the dough is of the same consistency and the molding has been uniform and correctly done, doughs proofed to the same height will have approximately the same volume. The second method is used in commercial bake shops and many testing laboratories.

There are three distinct purposes of the automatic proof box: (1) To relieve the person in charge of the baking test from constantly watching the dough. (2) To proof all doughs more uni-

formly to the same height or volume, and (3) to make it impossible to over-proof a dough. This proof box is automatic to the extent that when each dough has reached a given height, a signal is produced.

The method by which this has been accomplished is shown in Figure 1. The top view shows the shelf, made from a ⅜-inch aluminum rod fastened by machine screws between ½-inch aluminum bars. The side view shows two of these shelves with a pan of dough resting on the bottom shelf. Four ¼-inch machine screws are used to adjust the distance between the shelves, thus making it possible to proof the dough to any desired height.

There are several methods from which to choose in producing the signal—it may be audible or visual. Audible signals have given the best results, as the baker in charge is frequently required to leave the bake shop. Any number of electrical methods could be chosen to produce this audible signal. Whatever method is chosen, three requirements must be met: (1) The method must be exceedingly sensitive, so that it will not be rendered ineffective by the dry "skin" that may form on the dough in a proof box of low relative humidity; (2) the contact must be made with a minimum pressure, thereby not deforming the shape of the proofed dough; (3) the current conducted through the dough must be exceedingly small, so that a minimum of heating and electrolysis will result. Sensitive relays, electrostatic methods, currents of high frequency, direct currents with frequent make and break contacts, or currents obtained by oscillating circuits, are examples of the methods that can be used.

In the box shown an oscillating circuit was used. This circuit can be oscillated at either radio or audio frequency. If oscillating at audio frequency a detector stage is not necessary. The oscillator may be constructed from any standard radio equipment. As shown by the drawing, the following parts are used—one 0.00035 M. F. variable condensor, two high ratio audio transformers, two standard sockets, two 201 A tubes, one loud speaker, two 45 volt B batteries, one bell-ringing transformer, one grid leak (preferably variable), two rheostats, and wire as required.

The detail of the wiring is set forth in the figures. When the A and B currents are flowing, the circuit will oscillate strongly at audio frequency, owing to the powerful feed back of the first transformer. The second tube and transformer are so connected that they serve as an audio amplifier, whereby a louder signal may be obtained from the speaker. The variable condensor varies the

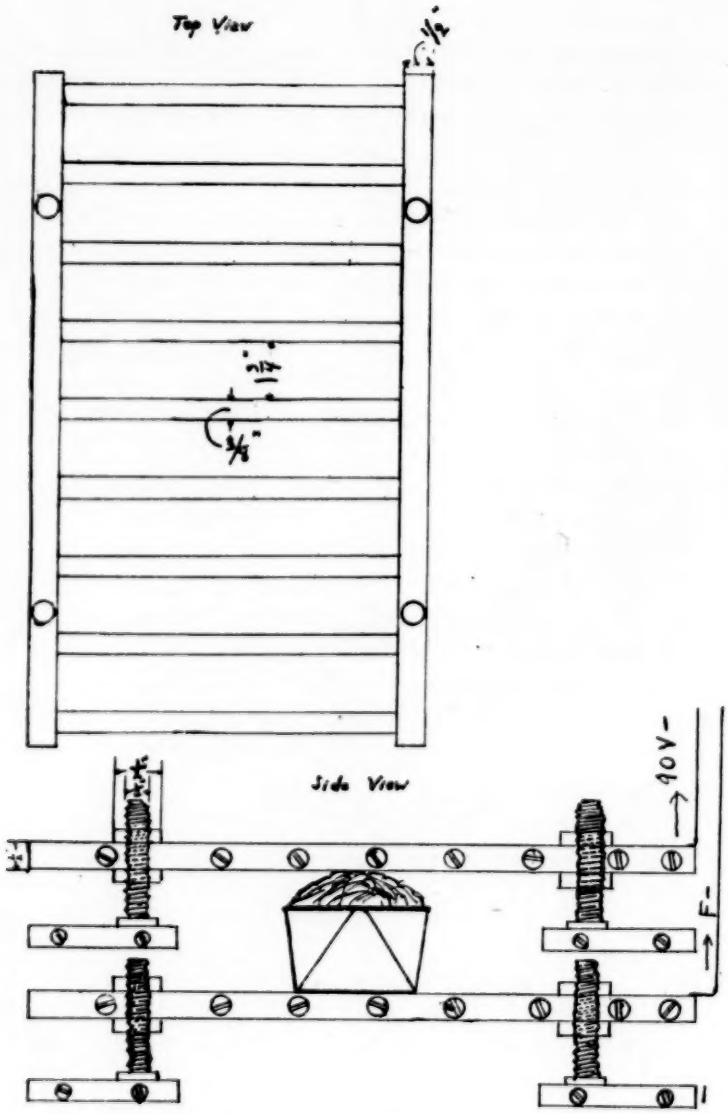

Fig. 1. Automatic Proof Box (Patent applied for.)

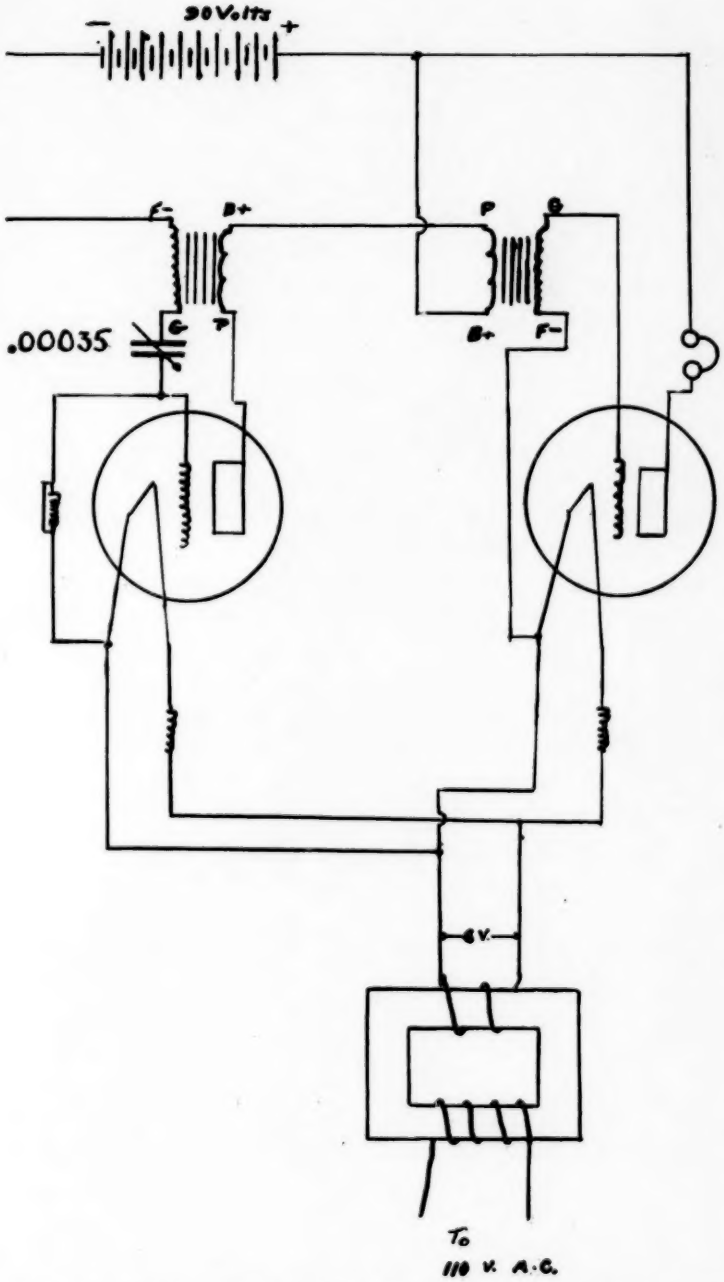

Fig. 2. Wiring Diagram of Circuit Used with the Automatic Proof Box (Patent applied for.)

Filament minus (F—) of the first transformer is directly connected to the filament circuit by a wire omitted from the drawing.

pitch of the whistle, or the same result may be accomplished by changing the value of the grid leak. The signal produced is very similar to the familiar time signals. As quality of tone is not essential, the A current is supplied by a bell-ringing transformer delivering 6½ volts, connected with the proper rheostats. The A current is allowed to flow the entire time the proof box is in use. The B current, however, is on only when one or more of the doughs has closed the circuit by forming contact between the two wires, one terminating in the upper shelf, the other in the lower. Thus a continuous path for the flow of the current from the B batteries is provided, and the signal is produced only when a dough is ready for the oven. The drain on the B batteries is negligible, as they are in use a very short time. The amount of current flowing through the dough is insignificant, so far as any heating effect is concerned. The apparatus is so sensitive that the signal may be produced by using a slice of bread to close the contact between the two shelves.

I have designed, constructed, and observed for several months such a proof box as is described, and have found the following advantages:

1. Doughs can be proofed more uniformly.
2. Time is saved by relieving the baker of the necessity of constantly watching each dough in the proof box.
3. It is almost impossible to over-proof a dough, as the signal is produced at the desired height.
4. The apparatus is very sensitive, producing contact through the "skin" of the dough without deforming the proofed dough.
5. It helps to eliminate one variable in the bake shop, and greatly adds to the confidence in laboratory bakes.

A GRAVIMETRIC PENETROMETER FOR MEASURING STIFFNESS OR TOUGHNESS OF DOUGHS

C. G. HARREL

Bakeries Service Corporation, New York City

(Read at the Convention, May 31, 1927)

Absorption of bread doughs is a variable factor of vital importance in the production of bread. Many authorities give as much importance to correct absorption as to correct fermentation period. Whatever importance may be attached to absorption, the fact still remains that in our bake shops and laboratories we determine the percentage of water to add to the dough by feeling the finished dough. This is especially true in the laboratories, as they are seldom equipped with machines to mold or divide the dough preparatory to baking. Hence the only way the laboratory worker has of judging the dough is by feeling it. From day to day one's sense of feel, relative to a stiffness that may have been set for a definite standard, varies considerably. Descriptive terms are the only means of expressing this standard stiffness.

Many methods have been suggested for determining the actual stiffness of doughs as they come from the mixing machines. None have proved entirely satisfactory. The chief objection to many methods is that considerable time is required to make the actual determination. A second objection is that the methods are very hard to duplicate. As the writer of this paper has as a hobby the ballistics of small firearms, the thought occurred that there might be some relation to the penetration of a cylinder or plunger of fixed dimensions acting under a definite momentum into bread doughs of varying characteristics. Hence experiments were conducted to determine whether or not there was any relation between the penetration of a plunger under definite momentum and the stiffness or toughness of doughs as they come from the mixer. The drawing shows the actual dimensions of the cylinder chosen with which to make the tests. Many cylinders have been tried but the one shown gave the best results. This cylinder is of definite composition and dimensions and can be very easily duplicated. To provide definite momentum the use of gravity was employed. The weight of this plunger is 1070 grams. It is 310.5 mm. long, 21.14 mm. in diameter, and the distance from the bottom of the plunger to the surface of the dough is 2.796 meters. The dough container was 4 inches in diameter and 12 inches in height. This

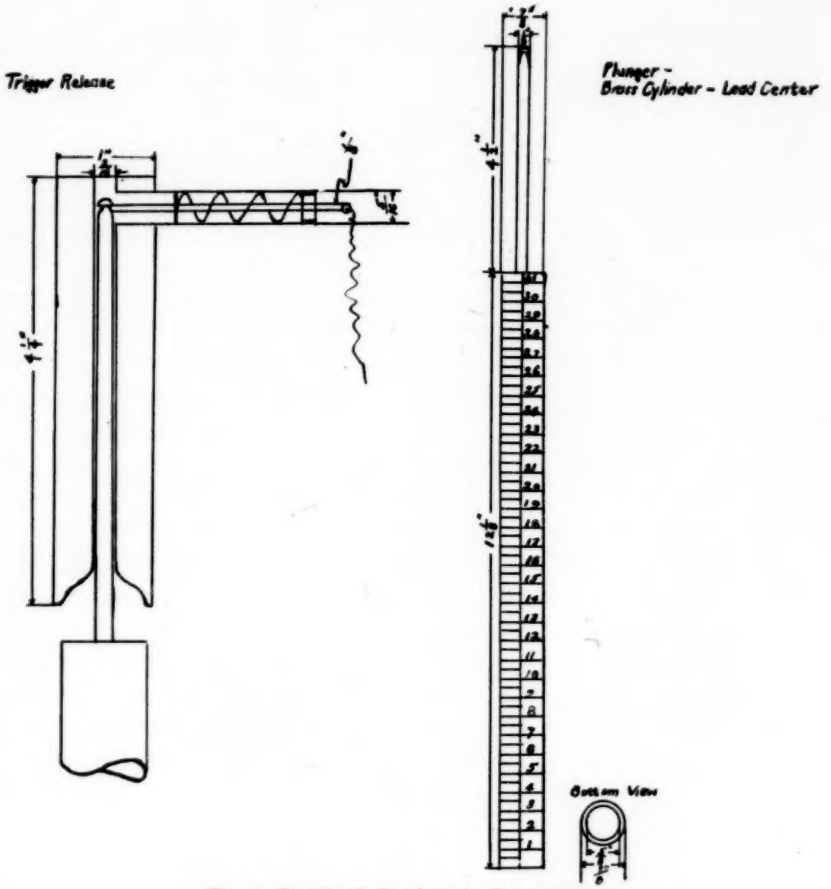

Fig. 1. Detail of Gravimetric Penetrometer

has an advantage because it remains constant and corrections can be made for the various altitudes. Barometric pressures could also be corrected for. This plunger or cylinder was dropped from the trigger arrangement also shown in the drawing. Importance must be attached to the ease with which this apparatus can be duplicated.

To obtain data upon various flours, relative to the depth of penetration of this plunger moving under constant momentum, a standard laboratory formula was chosen, and the following data were observed on the flours reported below. Data in all tables were taken immediately after the doughs were removed from the mixer. The mixer used was a Fleischmann or Bachman mixer running at 100 r. p. m. Unless otherwise stated the temperature of all doughs was 80° F.

Flour No. 1

Absorption %	Penetration cm.
60	11.0
65	14.5
70	19.0
75	24.0

From these figures it can be seen that on the same dough mixed under the same conditions, with only the absorption varying, the depth to which the plunger sinks increases as the absorption increases. Plotting the percentage of absorption as the abcissa and the distance penetrated as the ordinate, we find that the curve obtained is very regular. Further, the tangent at angle A is 0.867.

This was the control flour of the laboratory, and consisted of a dozen or more bread flours blended together in very small percentages. The analysis was protein 11.71%, ash 0.42%, moisture 12.73%.

Flour No. 2

Absorption %	Penetration cm.
50	10
55	14
60	20
65	23

If these figures are plotted as described, we find that the tangent of the angle A is 0.867. It is interesting to note that with flour No. 1 a good baking stiffness occurred with 60% absorption. With flour No. 2 the best baking stiffness occurred somewhere between 50% and 55%. From the distance penetrated, if the absorption were the only factor causing variation in penetration depth, flour No. 2 would have the same stiffness at exactly 51%, and as far as could be told by feeling the doughs this was correct. No. 2 was a cake flour with 0.35% ash, 8.6% protein, and 11.14% moisture. This explains the great difference in the percentage of water required by these two flours to bring them to the same stiffness.

Flour No. 3

Absorption %	Penetration cm.
60	15.00
65	18.75
70	22.80
75	27.50

Plotting as before we find that the tangent of angle A is 0.835. This flour was a very strong Northern Clear. The analysis was: ash 73%, protein 13.50%, moisture 12.50%.

Flour No. 4

Absorption %	Penetration cm.
60	8.75
65	14.00
70	17.75
75	21.00

This gives for the tangent of angle A, 0.817. This was a clear grade flour of 0.67% ash, 12.50% protein, and 12.60% moisture.

Practical bakers judging these doughs found that dough No. 2, with 65% absorption, from flour 1; dough No. 2, with 55% absorption, from flour 2, dough No. 1, with 60% absorption, from flour 3; and dough No. 2, with 65% absorption, from flour 4, were of the same stiffness. This is also indicated by the gravimetric penetrometer.

Thus far the experiments conducted showed a slight change in tangent A. The data recorded were taken once on each flour without any reference to time of storage of the flour. It was interesting to determine what effect the storage of flour would have upon the tangent of angle A.

Flour in 140-pound sacks was stored at a temperature of 72° F. Only two of these flours will be reported on, as that will illustrate the rate of change in stiffness per unit increase in absorption when flours are "aged" by storage.

Flour A, November 19, 1926

Absorption %	Penetration cm.
55	12.0
60	14.5
65	17.5
70	22.0

Tangent of angle A, 0.667

Flour A, December 11, 1926

Absorption %	Penetration cm.
55	12.0
60	14.5
65	17.0
70	21.5

Tangent of angle A, 0.633

Flour A, May 23, 1927

Absorption %	Penetration cm.
55	8.5
60	11.0
65	13.0
70	15.5
75	19.0

Tangent of angle A, 0.525

The doughs of May 23 were very different with respect to the decrease in stiffness when a unit increase of 5% in absorption was made. This could be observed by feeling the doughs by hand in comparison with a standard control flour not so aged. The decrease in tangent of angle A could not be attributed to drying out of the flour. On November 19 the moisture content of this flour was 12.5%, while on May 23, 1927, the moisture content was 11%. If the 1.5% moisture were the only factor that has changed in the flour we would expect a change in the position of the curve and not a change in its slope. The fact that the slope does so change, is evidence that the flour has undergone changes which affect its capacity to absorb water, as shown by tangent of angle A.

Flour B, November 16, 1926

Absorption %	Penetration cm.
45	5.8
50	10.9
55	15.2
60	18.9

Tangent of angle A, 0.874

Flour B, November 19, 1926

Absorption %	Penetration cm.
45	6.0
50	10.8
55	15.0
60	19.0

Tangent of angle A, 0.867

Flour B, December 11, 1926

Absorption %	Penetration cm.
45	5.8
50	8.7
55	12.0
60	17.0

Tangent of angle A, 0.748

Flour B, May 23, 1927

Absorption %	Penetration cm.
45	5.3
50	9.0
55	12.8
60	16.7

Tangent of angle A, 0.760

A decrease in the tangent of angle A is found in the doughs made from this flour. When tested by experienced operators the doughs seemed to resist slacking more when a unit increase in absorption of 5% was made than when doughs were first made from this flour. The tangent of angle A does not reach as low a value in flour B as in flour A. This is no doubt due to the differ-

ence in the percentage of protein, flour A having 11.5% protein with 0.40% ash, flour B having 8.2% protein with 0.37% ash.

It was desirable to determine the effect of grease or different degrees of polishes on the metallic plunger. Readings were taken with the plunger very thoroly cleaned by washing in ether, and on the same dough with the plunger greased. The results are:

Free from grease	Heavily greased
cm.	cm.
18.0	17.8
17.9	18.0
18.0	18.0
17.8	18.0

It was evident from these data that there was little difference in penetration from any grease that might get upon the surface of the plunger from the doughs. With an ungreased plunger the tendency to sink after the dough has been penetrated is much less than with a heavily greased plunger. Similar readings have been taken with different polishes on the brass plunger and no noticeable difference was observed. This proves that the friction between the dough and the plunger has no measureable influence on the penetration reading.

The effect of increasing the percentage of salt in a dough was studied with reference to the depth that the plunger penetrated. Following are the data obtained:

Salt	Penetration
%	cm.
1	23.0
2	20.0
3	18.2
4	16.43

From these figures it would be expected that the dough giving a reading of 16.43 would be the stiffest. This was not only the case, but an experienced person was able to place these doughs in the same order relative to stiffness as they would be placed by the data obtained from the plunger. It should be noted that all four doughs were taken from the mixer at the same time, and thus the person placing the doughs in relation to stiffness could make an immediate comparison.

The effect of the time of mixing at a given speed was next studied. The same formula was used throughout all these experiments except that in this one the ratio of ice and water was altered somewhat in order to vary the time of mixing yet hold the temperature of the finished dough constant. The total ice and water was equivalent to 65%. The results obtained are:

Time of mixing min.	Penetration cm.
5	17.20
7	16.91
10	16.50
13	16.50
18	16.50

It seems that there might be a very slight change in penetration due to the time of mixing; however, it is so slight with this particular flour and percentage of water used that it is almost within the limit of error. The results obtained here are not to be applied generally, as many flours under certain conditions increase in stiffness with an increased mixing time.

The effect of varying the temperature was next studied. In doughs whose final temperature was 70° to 75° and 80° F. the time of mixing varied, as the machine was not equipped with a cooling system; while in doughs at a final temperature of 85°, 90°, and 95° the mixing time was held constant by adjusting the ice and water. The data are:

Temperature of dough °F.	Time of mixing min.	Penetration cm.
70	4	14.25
75	6	14.00
80	8	15.50
85	10	16.87
90	10	19.00
95	10	19.87

From these data it seems that as the temperature of the dough increased the stiffness decreased. This is in general agreement with practical results obtained in the bake shop.

Suggestions as to Practical Use of Penetrometer

1. Should the same flour be under study by two persons widely separated, correcting for gravity and bringing the doughs to some arbitrary standard penetration reading, for example 11.5, it is believed that the percentage of absorption required to bring these doughs to this standard penetration distance can be determined with greater precision than if they try to arrive at the same stiffness by use of descriptive terms and the sense of feel.

2. This penetrometer has been found to be of value in a comparison of flours made from different wheat crops. It is difficult for a person to remember the exact stiffness of the doughs from the 1925 crops, when he attempts to make a comparison, in 1926. A standard penetration depth is a great aid. The tangent of the angle A will give valuable data relative to the maturity or environmental condition of the flours made from wheat in different years.

3. This penetrometer is of great value in studying the effect of different ingredients used in doughs; malts, for example. By holding the total water added constant and increasing the malt under test in individual doughs from 0% to 8% by steps of 1%, we obtain by the penetrometer readings a regular curve showing a decrease in stiffness as the malt percentage is increased.

4. It is of value in a bake shop in helping to obtain uniform stiffness. The percentage absorption means little. If a number of bakeries report the same penetration distance obtained by varying the percentage of water, it is believed that these doughs will be more uniform than if the production superintendent of each reports the percentage absorption his sense of feel and preconceived notions tell him to be correct.

5. This penetrometer is of practical assistance in many bake shop problems involving absorption and ingredients affecting the stiffness of the dough mass. It offers a definite numerical result that can be referred to at any time.

Summary

1. Readings of equal numerical value on the plunger indicate doughs of equal stiffness or toughness.

2. Tangent of angle A is a measure of the capacity of a flour to resist "slacking" when an increasing percentage of water is added.

3. The time of mixing doughs from the same flour, with the machine speeds, percentage of water, and particular flour employed had very little effect upon the depth of penetration.

4. As the temperature of a dough increases the stiffness decreases as shown by the penetrometer.

5. If the salt content of a dough made from the same flour is increased, the depth to which the plunger penetrates decreases, the percentage of water added being constant. This is in general accord with the results obtained by practice.

6. This apparatus is cheap, simple, and easy to duplicate. It is frictionless and is not affected by grease or other factors that might change its surface. With it several determinations can be run in a minute. It is believed to be of value in studying flours and various ingredients when incorporated into dough. It offers a definite numerical result which we believe is far better than descriptive terms now used.

FACTORS AFFECTING INTERPRETATION OF EXPERIMENTAL BAKING TESTS[1]

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Department of Agricultural Chemistry, University of Nebraska, Lincoln

(Read at the convention May 31, 1927)

A previous paper (1927) has indicated the rational basis upon which the experimental baking test must be standardized, if standardization is ever to be realized. The foundation of a **standard** baking test must be an adherence to that which is the underlying principle of **any** scientific standard test of a material. First, if the test is to be scientifically conducted, the material itself—in this case flour—must be the **only variable** in so far as this is possible. The fulfilment of this requirement demands that all operations and environmental factors must be fixed and controlled. Second, it is obvious that if the test is to be regarded as a standard procedure, these fixed and controlled conditions must be the same for all who purpose to use the test as such.

All will agree as to the desirability of the elimination of the personal factor in any standard test. It will also be acknowledged that a fixed and universally used method is the only procedure which can provide a common basis for the reporting and discussion of results.

The chief objection to the immediate adoption and use of a fixed experimental baking procedure appears to be based largely upon unfamiliarity with the type of method. Regardless of the logic and philosophy involved, the technologist will hesitate or refuse to change methods until he can be convinced that the new procedure will serve his own purpose as well as the old one or better. His chief interest is at once concerned with the matter of interpretation of results, to the exclusion of other features of a proposed method.

Basis of Interpretation

Regardless of the purpose or individual viewpoint in experimental baking, the characteristics and properties of the loaf constitute the real foundation for the interpretation and recording of results. The adoption of any fixed method will be greatly facilitated by an early discussion and demonstration of the meaning and

1 Published with the approval of the director as Paper No. 39, Journal Series, Nebraska Agricultural Experiment Station.

significance of the various loaf characteristics which result from the use of the method under consideration. The purpose of this report is merely to facilitate a general discussion of these matters in the light of recent studies and experiments using a fixed procedure based upon the formula of Werner (1925).

This method was selected for study chiefly for the following reasons: It has been effectively and successfully used over a period of years by its originator and others. It adheres to the principles of the fixed type of procedure. Its operation is simple and demands no exceptional manipulative skill, nor does it require unusually complicated or expensive equipment. The use of the small loaves provides possibility of better control of environmental factors with maximum economy of material and equipment than is possible with the commercial type of loaf, and without sacrifice of clearness in the final picture, which may be reproduced and closely duplicated at will, not only by the same operator but by different technologists working under the same environmental conditions.

Fermentation Tolerance

The main object of inquiry was the item of fermentation tolerance, since this appears to be an important matter of concern among many commercial bakers, and therefore of most industrial cereal chemists, who are more or less compelled to adopt the baker's point of view. How may fermentation tolerance be judged on the basis of **one** baking test? One may more clearly appreciate this if he will take the trouble to make a series of test bakes using a standard flour, varying fermentation time only. This may be varied by progressively regular intervals of, say, ½ to ¾ of an hour. In a number of experiments of this nature by the writers, using standard commercial flours, no decided "optimum" point has been observed, but merely a range over which there was little variation as to certain visible properties of the loaves.

Let us consider the case of one typical flour, following the fixed procedure, but varying the fermentation time by half hour intervals up to 6 hours. In the very short periods, from no time up to 1 or 1½ hours, there are the customary symptoms of a "young" dough with characteristic crust color, maximum rise in the pan, but very little oven spring and practically no break or shred. The interior texture also shows the usual well-known signs of underdevelopment. Passing over the range from the 1-hour to approximately the 4-hour period, certain symptoms become progressive-

ly more pronounced. There is a gradual diminution in crust color, a progressive decrease in height of rise in the pan, and correspondingly more oven spring, which gives the break and shred. The development of texture over this range is less pronounced, altho the tendency is toward smaller grain and frequently a slight elongation of cell structure in the longer periods.

Progressing beyond 4 or 5 hours of fermentation time, signs of exhaustion rapidly appear. There is a very pale crust color, little or no rise in the pan, slight oven spring, with tendency toward a "shell-top" break, and an undersized sickly loaf which may have small cells in the crumb, but a very compact texture. There have been no considerable variations in loaf volume up to the point where pronounced symptoms of exhaustion appeared.

After a few tests of this kind, one soon acquires the ability to appraise the situation from one bake. He is able to estimate from symptoms such as crust color and nature of break, the amount of additional fermentation which the flour in question could safely have withstood. In other words, fermentation tolerance may be estimated from a single baking test with a fair degree of accuracy, provided environmental conditions are fixed, closely controlled, and understood as to their bearing upon diagnostic symptoms. It should be perfectly obvious that if such symptoms as crust color are to have a definite meaning, oven temperatures must be controlled, both as to degree and uniformity, far more closely than is usually the case.

Altho the foregoing experiment is fairly representative of a typical commercial flour, we have found in experimenting with flours of various sources, varieties, and treatments, great fluctuations in the matter of fermentation tolerance or "stability." Certain flours have shown signs of exhaustion at 2½ hours that are identical with those which in other flours will begin to appear only after 5 or 6 hours of fermentation. This, we find, is generally the case with flours milled on a small experimental mill altho frequently with commercial flours as well. It has been our experience that the great majority of such flours, tho not in all cases, usually showed complete exhaustion when baked according to the procedure which calls for a 3½ hour fermentation period of 30° C. Flours milled from the same wheat, but on a commercial mill, showed much greater stability.

R. C. Sherwood, formerly of the Minnesota Agricultural Experiment Station, and A. H. Johnson, of the Montana Experiment

Station, have stated in private communications that they have found experimentally milled flours to be decidedly lower in diastatic activity than flours milled from the same wheat on a commercial type mill. We have verified this in our experiments, and find, moreover, that this condition of affairs completely accounts for lack of stability in experimentally milled flours as compared with commercial flours.

It was found that in using the fixed procedure with experimentally milled flours, one of at least three things could be done for the purpose of making the tests comparable with tests of average commercial flours. This end may be accomplished either by shortening the fermentation time, by lowering the fermentation temperature, or by increasing the amount of sugar in the formula, in the case of the experimentally milled flours. Decreasing the percentage of yeast would doubtless serve a similar purpose. At present, however, we would recommend the use of 5% instead of 2½% sugar when applying this particular fixed baking method to experimentally milled flours. This appears to serve approximately as the sugar differential properly to compensate for average diastatic discrepancies between experimental and commercial flours. Stability, or fermentation tolerance, as measured by visible bread characteristics, may be indefinitely prolonged in any flour properly milled from sound wheat, simply by increasing the sugar in the bread formula.

It is interesting, altho in no way surprising, to note that when a series of miscellaneous flours was experimentally baked by this method, we found an almost perfect positive correlation between crust color and diastatic value of the flour, the latter being estimated on separate portions of the flours, respectively. We believe that in this type of baking method, crust color furnishes almost as useful an indication of diastatic value as does a special diastatic value determination. Sherwood and Bailey (1926), in supplementing the natural diastatic power of sound normal flour with flour from germinated wheat, have noted a positive correlation between crust color and amount of germinated wheat flour used.

These experiments suggest the idea that fermentation tolerance, or stability, as ordinarily regarded from the production viewpoint, is an item which is associated more closely with the factor of gas **production** than with that of gas **retention**. That is to say, that with the yeast constant, diastase or sugar is the determining factor rather than gluten quantity or quality, as is frequently assumed to be the case. In experimenting on this idea with a

considerable number and variety of flours, we find that the fermentation time can be extended even to the stage of incipient putrefaction of the gluten, without substantially altering the **appearance** of the bread, provided only that sugar is added to the dough shortly before panning. We have found that so far as **visible physical properties** alone are concerned, bread from a 12-hour sponge is almost identical with that from a 4-hour sponge, under both experimental and commercial shop conditions. Similar results with sponge doughs are reported by Harrel (1926).

Regardless of other implications which may be involved, it is apparent that gluten is far more resistant to ordinary yeast fermentation that it is generally given credit for, and these experiments offer no justification for a belief that proteolytic enzymes, as naturally present in flour or yeast, have any important bearing upon bread production. It is evident that there is little or no relation, within extremely wide limits, between gluten and fermentation tolerance, using the latter term from the usual production standpoint.

Oxidizing Agents in Flour and Bread Production

What then is the real foundation for certain apparently legitimate complaints from the baker as to flour quality or uniformity? What factors are responsible for the different so-called "age" characteristics exhibited by various flours even when baked by the same procedure, and having the same ash and protein content? Differences in wheat varietal characteristics undoubtedly constitute one factor. There is good reason, however, for the belief that the more frequent basis of such lack of uniformity is the modern use of powerful oxidizing agents, both in the mill and in the bakeshop.

Some of these oxidizers are readily recognized under names such as Agene, Chlorine, Novadel, Arkady, and Paniplus. There are others. The first three are usually regarded as "bleaching agents," and the latter two as "yeast foods." These oxidizers, aside from their bleaching properties, act powerfully upon gluten, producing to a greater or less degree the familiar "age" symptoms. The nature and severity of these symptoms will depend upon both the kind and amount of oxidizer used. Very minute quantities of certain oxidizers will frequently produce relatively tremendous effects, as is now becoming more generally appreciated. If slightly larger amounts are applied, the results may be disastrous. The

more powerful the oxidizer, the more care should be exercised in regulating and controlling the amounts used.

Since the use of oxidizers has become almost universal in the industry it is well for the cereal chemist to take them more seriously into account, especially as to their influence upon characteristics and uniformity in bread. It may be decidedly appropriate, under modern industrial conditions, to apply definitely the recognition of this situation in the performance of experimental baking tests.

The Differential Test

An ingenious application of this principle in experimental baking tests has been employed, based upon the well known effects on wheat flour of certain oxidizing agents, such as peroxides, bromates, and persulfates. Herman (1927) has suggested the use of a "differential test," in which ordinarily two loaves are baked; one by a regular fixed procedure, and the other with the addition of a very small but definite quantity of a strong oxidizing agent, either as the pure chemical or as one of the popular commercial "yeast food" preparations known to contain an oxidizer.

A test of this nature is capable of supplying valuable information to both the mill and the bakery chemist. Applied to the mill, it can be made to serve as a basis for informing the miller as to the tolerance toward oxidizers of any particular lot of wheat, and he may regulate his blending and bleaching processes accordingly. As the baker ordinarily subjects his flour to additional treatment with oxidizer, it would be to the decided advantage of both the baker and his chemist to have a test which will indicate how much additional oxidizer the flour will stand, if any. This tolerance may vary with different wheat varieties, different localities, different crop years, and different stages of maturity of a crop.

In applying this "differential test" to flours of various sources and descriptions, we have ordinarily made two test bakes on each flour, in one using the regular fixed method as indicated, but in the other varying the procedure merely to the extent of the addition of 1 mg. of potassium bromate, this being applied in solution at the time of mixing the dough. For present purposes it will suffice merely to indicate the general nature of the results of our experience with this test.

When we have applied the test either to experimentally milled, untreated flours, or to "unbleached" commercially milled flours, an appreciable and often remarkable stimulation usually results from the addition of 0.001% of bromate. There is generally a pronounced, and frequently an extraordinary increase in loaf volume, and, in our experience, a decided refinement or development in texture. It has furthermore been our observation that degree of stimulation is roughly proportional to protein content. It is not unlikely that herein lies the foundation for the modern practice of paying premiums for high protein wheat. Correlation between loaf volume and protein content is, we have reason for believing, much higher in commercial flours which have ordinarily been treated with oxidizers, than in experimentally milled or untreated flours. It is reasonable to assume that the response of an untreated flour to this differential test should be in large measure indicative of the tolerance of the wheat in question to oxidizers such as are widely used by the miller incidental to the bleaching process. Flours showing the greatest stimulation in the differential test may be regarded as the least susceptible to overtreatment by the miller, and vice versa.

In applying the test to commercially milled and treated flours, the stimulation is much less pronounced, as a rule. The effect of the oxidizer is sometimes quite the reverse of stimulation, as may be evidenced by decreased loaf volume, rough or torn crust, and a more or less ragged, uneven crumb texture. Such cases may constitute strong evidence either of overtreatment by the miller or of low tolerance toward oxidizers on the part of the wheat, or perhaps a combination of both factors. Manifestly, therefore, the differential test should be of value to the bakery control chemist, especially where the use of oxidizing agents is a part of the bakery program. Presumably, in this connection, a differential test may show one of at least four things: (1) It may indicate that the flour has been overtreated to an extent which renders it unadaptable for use under certain specific shop conditions. (2) It may suggest that treatment has already been to such an extent that the use of additional oxidizer in the bakeshop is inadvisable. (3) It may point out that additional oxidizer should be used in order to produce the characteristics desired by the baker. (4) The test may conceivably be adapted to indicate how much oxidizer the baker may safely use in his formula, in order to produce the properties desired.

Summary and Conclusions

This paper, altho based upon experimental work and verification of experiences of others, is intended merely to serve the purpose of a general discussion of factors upon which one may substantially base interpretation of baking tests conducted according to the fixed type of procedure. A method based upon a report of Werner (1925) has served as the foundation of the experimental work from which these general conclusions are drawn. The use of a differential test is advocated as an added modification to the baking test, which may thus serve as an especially valuable means for taking account of the use of powerful oxidizing agents, which prevails throughout the modern milling and baking industries. The essential conclusions of the entire discussion are:

1. In so far as visible bread characteristics are concerned, "fermentation tolerance" is, within far wider limits than is generally appreciated, almost entirely associated with the gas production factor, i. e., sugar or diastase.

2. Under proper control of environmental conditions, following the fixed type of baking procedure, crust color is in almost perfect correlation with diastatic activity of the flour itself.

3. Experimentally milled flours generally are much lower in diastatic value than flour commercially milled from the same wheat, and allowance should therefore be made in any fixed standard baking method.

4. It is not likely that gluten, as to either quantity or quality, is as important a factor in the matter of fermentation tolerance or stability as is generally supposed.

5. Under modern industrial conditions the use of oxidizing agents may be the chief factor which determines bread characteristics, aside from differences in such items as wheat varieties and flour grades.

6. Gluten is profoundly affected by minute quantities of oxidizing agents such as are universally used by both miller and baker. The effect is usually one of stimulation and "development" where the treatment is properly controlled, but if excess of oxidizer is used the result is detrimental, producing symptoms of more or less advanced "age." Other things being equal, high protein flour is stimulated to a greater degree by oxidizers than flour of low protein content. Tolerance toward oxidizing agents may reasonably be regarded as roughly proportional to protein content, a

condition which may be the real basis of the modern price differential between high and low protein wheat.

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REPORT OF COMMITTEE ON STANDARDIZATION OF THE EXPERIMENTAL BAKING TEST, 1926-1927

I. General Report—Recommendation of "Fixed" Type of Procedure[1]

By M. J. BLISH, Chairman
Department of Agricultural Chemistry,
University of Nebraska, Lincoln

(Read at the Convention, May 31, 1927)

The first step taken by the committee was to submit a questionnaire to the membership of the American Association of Cereal Chemists. The purpose of this questionnaire was to ascertain, in a general way, the modern attitude of cereal chemists as to various important aspects of the laboratory baking test. Responses were received from 140 persons, most of whom indicated that they habitually either perform or supervise experimental baking tests.

For the purpose of this report it is considered advisable merely to discuss briefly the important issues developed from the questionnaire, omitting details. An overwhelming majority of cereal chemists regard the laboratory baking test as the most important flour test. There were more than 50 different varieties of answers to the question "What information do you expect your baking test to reveal?" Precise interpretation of these answers is difficult because of uncertainty as to the exact intended meanings of terms used.

1 Published with the approval of the director as paper No. 40, Journal Series, Nebraska Agricultural Experiment Station.

Approximately one-third of the replies stated that the individual is satisfied with his present method. Nearly 20 per cent are not thus satisfied. Another 20 per cent are only partially satisfied. The remainder either qualified their statements on this point or were, apparently, undecided.

Individuals differ greatly as to range of variation in loaf volume permitted in duplicate bakes. There were more than 50 varieties of answers to the question "What, in your opinion, are the chief faults of the average experimental baking method?" Twenty-five answered that the chief fault lies in the personal element. This was the only answer to this question in which there was precise agreement among more than 8 individuals.

There is a decided preponderance of opinion that the development of a satisfactory standard procedure is possible and that it should be attempted. Only 4 expressed an opinion definitely to the contrary. A few others were doubtful. Opinion was equally divided as to whether there should be but one standard procedure or several procedures. A large majority indicated the belief that if one procedure is found preferable it should include the possibility of several bakes, varying only the fermentation period. This would indicate that the ascertainment of fermentation tolerance is generally regarded as the chief object of the test.

Aside from the foregoing items, the questionnaire served merely to emphasize and substantiate the findings of Fitz (1924), who reported results of a study of experimental baking procedure of 44 laboratories, respectively, and found that "very few laboratories are using anything like the same formula, method of procedure, etc."

Following the questionnaire the chairman of the baking committee visited a number of commercial and industrial laboratories where baking tests are an important routine item, for the purpose of observing various methods which are being used successfully in commercial practice. In this connection acknowledgement is due to laboratories which have courteously and generously extended to the writer the privilege of seeing their respective methods in operation. Among them were: W. E. Long Co., E. E. Werner, Industrial Appliance Co., American Institute of Baking, Larabee Flour Mills Co., Gooch Milling Co., and the Crete Mills.

This activity materially assisted in the reaching of several definite conclusions, which may be briefly stated as follows: Methods of laboratory test baking roughly group themselves into

two classes or types, which, for convenience, may be designated respectively as the "fixed" and the "variable" types. The variable type is used by the great majority of cereal chemists, and admirably serves its purpose in many instances. In this type of method the procedure is varied with different flours. The attempt is made to handle each flour in accordance with its own special requirements in order to produce an "optimum" loaf, the variation in technic being based either upon certain predetermined properties of the flour, upon behavior during fermentation, or upon a combination of both factors. Success here depends upon the personal skill and experience of the operator in both manipulation and interpretation. In the fixed type, all flours (at least within a given class) are subjected to the same manipulative procedure and environment so far as possible. In this case, operative skill is a minor factor, interpretative skill and experience being the important considerations.

It is the belief of the writer that in the project under consideration we are first of all confronted with the necessity of disposing of an issue upon which depends the success or failure of the entire project. Of these two types of baking procedure, the "fixed" type is the only one which can reasonably be expected to serve the purposes of a **standard** test. This is an established and recognized principle underlying the standard scientific testing of **any** raw or partially refined material. The foundation for this principle is, of course, the universally accepted belief that a scientific test of a material should involve but **one variable,** which must be the material itself, so far as this requirement can be satisfied.

It is not to be supposed that this fundamental principle can be disregarded in any attempt to standardize our most important flour test. The "variable" type of procedure, altho extremely useful for certain purposes, cannot be regarded as a proper foundation for a **standard** method, as it involves the testing of operative skill as well as of the material itself. The writer has to his personal satisfaction critically verified these conclusions in the laboratory.

There is among cereal chemists a widespread opposition to the use of a fixed method of experimental baking. It has seemed necessary first of all to reach an agreement, at least among members of the committee, as to the matter of the fixed vs. the variable type of baking procedure. With this idea in mind a meeting of the committee was held at Lincoln in January. The meeting was of four days duration, and all members were present except one,

who sent an official representative. In addition to members of the committee, there were several invited guests, including representatives of the United States Department of Agriculture, and two local industrial cereal chemists.

At this meeting the chairman first of all asserted and discussed in detail his conviction that the fixed type of procedure is the one which must serve as the foundation for a standard laboratory baking test. This detailed discussion has been published in Cereal Chemistry (1927), and needs no further elaboration in this report.

Following this discussion, there were demonstrations of a fixed type of method, in order to indicate that such a method not only is capable of standardization but that it also permits of useful interpretation of results. The particular method used at this meeting was one of which certain features have been described by Werner (1925). This work involved, among other items, trials by the individual committee members, who obtained remarkably concordant and satisfactory results, even tho most of the operators were attempting the special technic of procedure for the first time.

As the chief outcome of the January meeting, the committee has unanimously and definitely endorsed the idea that the fixed type of procedure is the one which must be adhered to as closely as possible in establishing our foundation for a standard laboratory baking test. The reaching of this decision may be properly regarded as the major activity of the baking committee during the last year, and it constitutes the real essence of this report.

If this report is acceptable to the association, the most important and essential preliminary step of the entire project will have been taken. The subsequent order of business obviously will be the study, discussion, final selection, and adoption of details. This will be no small problem. It will require carefully planned and well executed collaborative work, involving the expenditure of time and funds, unselfish co-operation, readjustments of ideas, and mutual concessions.

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II. Comments on the Proposed Baking Test

By L. H. Bailey
U. S. Department of Agriculture

When I heard the fixed type of baking procedure described by Dr. Werner at our St. Louis convention, I did not give serious consideration to the subject. Even when it was presented to the baking committee at Lincoln, in January, I was skeptical as to the suitability of the method. But after we had it demonstrated to us with different types of flour, and the differences in results were pointed out to the committee and we were shown how to interpret the results, I began to gain confidence in the method. Then when seven of us used this method with two flours of different types, and each produced loaves characteristic of the flour, while differing among themselves because of the personal equation in handling the doughs, nevertheless showing great similarity, I gained further confidence. The loaves from one flour were quite different from those of the other flour, altho there were certain characteristics when loaves were made by the same operator. As a result of this committee meeting I felt that there were possibilities in the method and desired to try it out in my own laboratory. This I did in a number of ways, after obtaining the required apparatus.

The method was tried with 2 graham, 2 soft wheat, and 7 hard wheat flours. The same flours were also baked by our regular laboratory method. Our conclusion in regard to these comparative bakes was that loaves made by the proposed method showed differences that were more pronounced than those made by the regular method.

We then made comparative baking tests by the two methods on 31 samples of commercial "Baker's patents." In these tests some of the flours showed up better by the regular method than by the proposed method. In the regular method we used a shorter fermentation period than in the proposed method, and some of the weaker flours could not withstand the long fermentation required by the proposed method.

Next, 12 samples were baked by the proposed method and duplicate bakes were made, only to the latter 1 mg. $KBrO_3$ was added to 100 grams flour. Five loaves out of the 12 had larger volume when bromate was added. In general, however, the grain of the bromated loaves was not as good as the corresponding plain loaves. Again, the formula of the proposed method was trebled

and the doughs were mixed in a mechanical mixer and baked in shallow commercial type pans. Otherwise the procedure of the proposed method was used, but these loaves did not show as marked differences as the small loaves. Whether this difference in results was due to the difference in shape of the pans has not been determined.

Dr. Emily Grewe and the writer, working in the same laboratory, made comparative bakings on the same flours using as nearly the same procedure as possible. In 3 cases out of 5 one of us produced loaves of larger volume than the other. The loaves made by one operator had medium size breaks and even shred, while those made by the other had larger breaks and more uneven shred. These differences are attributed largely to differences in molding the loaves.

From the results of all tests made, it is my conclusion that the proposed method is more capable of showing differences in flours than the methods I have used heretofore.

L. H. Bailey also reported for Dr. Emily Grewe of the United States Department of Agriculture as follows:

Comparative baking tests were made by mixing with three types of mechanical mixers and by hand. With the machine mixed doughs, the proposed formula was quadrupled, and when mixing was completed aliquots were taken to represent 100 grams of flour, otherwise the proposed method was followed. The mechanical mixers used were the Fleischmann, Hobart, and Werner-Pfleiderer.

On the Fleischmann mixer 8 loaves of bread were made from each of two flours. With flour "A" the average volume was 367 cc., maximum 380 cc., and minimum 355 cc. With flour "B" the average was 375 cc., maximum 385 cc., and minimum 365 cc.

Two loaves from flour A were made by each of the other methods of mixing with the following results: with the Hobart mixer the volumes were 370 and 370 cc., with the Werner-Pfleiderer the volumes were 370 and 365 cc., and by hand mixing they were 380 and 370 cc. respectively. In general the score on all the loaves was nearly the same.

The results may be summarized as follows:

1. A close similarity in texture was found in the 14 loaves of bread made from the same flour but mixed by different methods.

2. A variation in loaf volume from 355 to 380 cc. was encountered in the 8 loaves of bread made from doughs mixed in the Fleischmann mixer. When other bread mixers were used the loaf volumes came within these limits.

3. Break and shred on the 14 loaves made from the same flour and mixed with the different mixers had a close resemblance.

4. The 14 loaves differed in appearance from the 8 loaves made from a different flour.

Conclusion

The difference in the baked loaf of bread as a result of a difference in the type of mixer is not a significant factor in making bread by the proposed method.

III. Observations of Baking Tests

By R. C. SHERWOOD and C. H. BAILEY

The pronounced interest in the "fixed" method of experimental baking, particularly as applied to tests of small quantities of flour, demanded a careful study of test baking with a variety of flours, each baked a sufficient number of times to provide data for statistical analysis. The experiments carried out were designed to assist in developing a standard experimental baking procedure. For various reasons we collaborated in this work, and the baking tests were made in the laboratories of the Division of Agricultural Biochemistry, University Farm, St. Paul, Minn.

The following observations are based upon replicated tests of 21 samples of flour milled from different types of wheat. Among these different wheats were 6 northwestern hard spring, 3 southwestern hard winter, 2 mixed hard winter and hard spring, 3 soft red winter, 7 western including hard winter, soft white, and hard white. Grades of flour ranging from short patent to straight, including one clear, were represented.

Two different baking procedures were employed. The one hereafter referred to as the large dough method was the one used at the Minnesota State Experimental Flour Mill, while the other, hereinafter called the small dough method, was very similar to the procedure proposed by Werner.

The formulas follow:

Ingredients	Large Dough		Small Dough
	Grams	Grams per 100 grams of flour	Grams
Flour	350.00	100.0	100.0
Yeast	10.5	3.0	3.0
Sugar	10.5	3.0	2.5
Salt	5.25	1.5	1.0
Fat	6.5	1.85	none
Water	sufficient		sufficient
Fermentation			
First punch	105 (30°)		120 (30°)
Second punch	30		60
Third punch	15		30
Pan	15		at third punch
Proof	65 (34°)		55 (30°)
Bake	35 (220°)		25 (220°)

Several variables were studied including the size of the dough, absorption, fermentation time, and hand vs. machine mixing. Approximately five hundred bakes were made. Baking tests of each of the 21 flours by the large dough method were replicated 12 times and those made by the small dough method were replicated 8 times. The smaller number of replicates by the small dough method was decided upon because of earlier experiences which indicated less variability by this method.

The baked bread was scored in order to provide a permanent record of the characteristics of the loaves. Volume was determined by seed displacement. The other scores represent our effort to express numerically the various qualities of the bread as reflected in crust color, character of crust, loaf symmetry, grain and texture of crumb. Color was also scored, but no reference has been made to the resulting data in this report. These scores were each based on an arbitrary perfect score of 100 in order that the values assigned could be more easily subjected to a statistical analysis. This manner of scoring also permitted assembling the values for the various loaf characteristics, in order to determine the total loaf score. In assigning these scores an effort was made to record only those qualities which might be regarded as measures of flour properties rather than those which register the skill of the baker.

Coefficient of correlation of the loaf volume of bread baked by the two methods was computed. The coefficient $r = 0.824 \pm 0.047$. This is a large coefficient of correlation, indicating a pronounced tendency for the loaf volume to vary in the same direction and by the same magnitude when the tests were made by both methods. That the same ratio maintains between large loaf

volumes and small loaf volumes in progressing from minimum to maximum volumes is evident from the data in the following table. These data are arranged and averaged by groups, and the difference in the ratio of volumes determined by the two methods is of small magnitude in the instance of the three groups.

Range in volume of large loaves	Large dough mean volume	Small dough mean volume	Small dough vol. / Large dough vol.
	cc.	cc.	
Less than 2000 cc.	1921.8	411.9	21.43
2000-2300 cc.	2142.5	435.3	20.31
More than 2300 cc.	2346.1	482.1	20.55
All samples	2145.2	444.7	20.84

The ratio between weight of flour and volume of loaf is not the same for the two methods. The average volume of loaf per gram of flour for the 350-gram dough was 6.13 cc., for the 100-gram dough 4.45 cc. These figures show that loaf volume for large dough bakes cannot be calculated from loaf volume for small dough bakes by simple proportion. Aside from the effect of machine mixing, it appears probable that the larger ratio of crust to crumb in the instance of the small doughs is responsible for the smaller volume of bread per gram of flour.

Standard deviation and coefficient of variability in the 21 series of bakes by the two methods were computed. The average coefficient of variability of the large dough bakes was 4.18 per cent for 12 replicates, and for the small dough bakes, 2.44 per cent for 8 replicates. Thus, the small dough bakes evidenced a coefficient of variability (C.V.) of only 58 per cent of that of the large dough bakes when the C. V.'s are directly compared on the basis mentioned. It is believed that the lower coefficient of variability in the case of the small doughs is due largely to the greater uniformity in molding the small doughs (hand molding was employed in both cases), and to the diminished effect of one dough upon another when two or more loaves were placed in the oven at the same time.

Grain and texture scores were combined for purposes of calculating the comparative properties of the crumb. Using the mean value of the sum of grain and texture scores of replicated bakes, the coefficient of correlation between large and small doughs was computed in the instance of the 21 flours. The coefficient of correlation was $r = 0.993 \pm 0.002$, which is an extremely high value, and shows that the grain and texture of the bread from each individual flour was scored practically the same when baked by the two methods used.

The relation of the total scores recorded in the two baking procedures was similarly computed. The mean value of each characteristic scored (excluding loaf volume) was determined for the replicate bakes of each of the 21 flours baked by each method. The total scores were calculated by averaging the values assigned to loaves baked from each flour by each method. Coefficient of correlation between total scores obtained with the large doughs and those with the small doughs was found to be 0.925 ± 0.021. This high value shows that the characteristics of each flour as exhibited in the baked loaf were essentially the same whether fermented and baked in a small or a large dough.

The studies relating primarily to the effects of the weight of flour used in making the dough have shown a high correlation between the numerical values assigned as scores when the large and small doughs were compared. Stated in other terms, this means that each flour exhibited its individual characteristics in the baked loaf, and that these characteristics were practically the same for each given flour regardless of the fact that 350 grams of flour was doughed and baked in one series of tests, and 100 grams of flour was doughed and baked in another series of tests. The greater coefficient of variability with the large doughs shows, however, that more uniform results between replicates may be obtained with the small doughs, and hence it may be anticipated that a limited number of baking tests with the small doughs will give more reliable information concerning the baking properties of flour.

Tests were made to determine the effects of varying the absorption. Increase of 2 per cent in absorption above that which was deemed optimum for a particular flour was observed to have an appreciable effect upon the properties of the resulting bread. This increase in water used tended to reduce loaf volume and impair the grain and texture of the bread. The same decrease in absorption below the optimum had less effect upon the properties of the bread. It is concluded from these tests and from previous experience that it is quite impossible to test adequately the properties of the flour without adjusting the quantity of water added to the absorptive properties of the flour.

In the attempt to standardize all the conditions of the experimental baking test and to limit the variables to the flour alone, it is probable that conditions for fermentation are controlled better by adding sufficient water to the dough to obtain dough of uni-

form consistency or degree of plasticity, allowing a variable quantity of water according to the imbibitional capacity of different flours, than by adding the same quantity of water to each dough. Naturally it follows that the judgment of the operator must be relied upon to determine the "optimum" consistency until there are devices available to make the test accurately. When the operator is in doubt concerning the optimum of absorption for a particular flour, it might be desirable to conduct a series of baking tests with varying quantities of water. We are of the opinion that the experienced operator can adjust the absorption within the necessary limits and with less unfortunate results than are attendant upon the use of a fixed or uniform quantity of water with all types and grades of flour.

Increasing the period of fermentation beyond the "optimum" resulted in an impairment of the dough quality. Similar decreases in the time of fermentation up to 60 minutes had a less pronounced effect.

Machine mixing produced a dough which yielded bread superior to that produced by hand mixing. After conducting a large number of baking tests we are of the opinion that a machine mixed dough made with 300 or 400 grams of flour, aliquoted into portions representing 100 grams of flour immediately following the mixing operation and these portions fermented for varying lengths of time, both shorter and longer than the estimated "optimum" fermentation period, will afford a better measure of the important flour properties than a series of hand-mixed doughs made with 100 grams of flour which are all fermented for a uniform period of time. It is further believed that machine mixing when properly regulated will result in more uniform doughs than will hand mixing when a large number of doughs must be mixed by a single operator. It is recognized that the variability due to hand molding is probably large, but it is believed to be smaller with the small doughs than with the large doughs. Machine molding would probably be preferable if machines were available for molding small doughs.

IV. Comments by C. B. Morison, American Institute of Baking, Chicago

Following the Lincoln meeting of the committee in January, 1927, which was attended by I. A. Berg, of the American Institute of Baking, as the writer's proxy, considerable attention was given

to the "fixed" type of procedure for conducting the baking test, based in general on the method demonstrated before the committee at Lincoln.

The "fixed" type of procedure appears to be fundamentally sound, and tho the method demonstrated at Lincoln employs smaller quantities of flour with the consequent production of a proportionately small test loaf, it indicates, in general, similar information on the characteristics of the flour as that obtained with larger amounts of flour and a larger test loaf as ordinarily employed.

We are now engaged in developing a "fixed" type of procedure for the baking test in relation to the requirements of our work. The details of this work will be available to the committee for their information in the near future.

V. Comments by L. D. Whiting, Chief Chemist, Ballard & Ballard Co., Louisville, Ky.

The work which we did this year on the Standard Baking Test was done with soft wheat flour. We have always used the baking test as a criterion of our soft wheat flour streams in the mill, but previous to January 24, 1924, the method of procedure in use in our laboratory would have been classified as a "variable" type of procedure.

Since this date, we have applied the "fixed" principle to the formula we already had in use. All the work we have done has been limited to the "large" dough of a pound and a quarter in size, as we have not had the equipment to bake the 100-gram doughs.

Our results may be summarized briefly in the two following conclusions:

1. Using the fixed type of procedure it has been possible to obtain more uniform volumes on successive days, in baking any one grade of flour, than was possible with our former "variable" type of procedure.

2. There are larger differences or spreads obtained between the volumes of different grades of flour when baking according to the fixed method than when the variable method is used. The same is true of crust color.

We therefore endorse the fixed principle of procedure for the baking test, and are anxious for the details to be settled.

REPORT OF THE COMMITTEE ON METHODS OF ANALYSIS FOR THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS

D. A. COLEMAN, Chairman

The Methods committee appointed for 1926-27 consisted of F. A. Collatz, H. C. Fellows, M. D. Mize, C. B. Morison, and D. A. Coleman.

The activities of the committee this year were in two distinct fields. The first activity was concerned with the usual collaborative work and the second was in relation to the enlargement and revision of the Book of Methods of Analysis. The collaborative studies will be taken up first.

Collaborative Studies

Collaborative Moisture Studies

At last year's convention[1] this association adopted the vacuum oven method and the 130° C. air-oven method as tentative methods for the analysis of moisture in flour, meals, and feeding stuffs.

Desiring to obtain further analytical data on the efficiency of these methods, samples of these materials were sent out for collaborative moisture study. The materials selected were flour, ground wheat, and bran. Enough of the carefully mixed materials was sent in air-tight containers to sixty-five collaborators with the request that moisture determinations be made upon them in accordance with the instructions given in Cereal Chemistry, Vol. 3, No. 4, pages 277 and 278.

The results obtained are given in Table I, mimeographed copies of which have been supplied you. You will note in reading this table that the average moisture content found for the wheat was 9.89 per cent. Applying the tolerance voted upon by the association in 1925[2], namely, 0.25 per cent, so that half of the tolerance is above and half below the average moisture percentage found, i. e., from 9.77 to 10.02, it will be seen that 74 per cent of the collaborators were within acceptable checking figures. With flour the average moisture found was 11.40 per cent. Conceding any percentage between 11.28 and 11.53 as correct (as this range would take care of the 0.25 per cent tolerance), it will be found that 77.8 per cent of the collaborators were within acceptable checking figures.

1 Cereal Chemistry, Vol. 3, No. 4, p. 297, par. 16.
2 Cereal Chem. Vol. 2, p. 251.

Less success was had in making moisture tests on bran, as only 68 per cent of the collaborators checked within the average and allowable tolerance, i. e., between 5.42 and 5.67 per cent. Considering all three samples, approximately 71 per cent of all collaborators obtained satisfactory results by these methods.

TABLE I

MOISTURE CONTENT OF SAMPLES OF WHEAT, FLOUR, AND BRAN SENT OUT FOR COLLABORATIVE STUDY

All tests made by the 130°C., air, 1-hr. drying, or vacuum oven method. See Cereal Chemistry, Vol. 3, No. 4, pp. 277 and 278.

Collaborators	Per cent moisture		
	Wheat	Flour	Bran
Barker, H. C	10.00	11.38	5.52
Blish, M. J	9.66	11.12	5.52
Bliss, F. W	10.02	11.54	5.48
Briggs, C. H	9.99	11.49	2.45*
Carr, Frank	10.15	11.66	6.37*
Christie, A	9.85	11.43	5.55
Collatz, F. A	9.95	11.50	5.52
Craik, A. P	9.75	11.25	5.25
Curtis, A. E	9.97	11.44	5.54
Davis, C. F	9.92	11.37	5.49
Dixon, H. B	9.89	11.40	5.42
Durham, R. K	10.06	11.78	5.63
Fellows, H. C	9.94	11.39	5.46
Fine, H. S	9.90	11.09	5.79
Flohil, J. F	9.92	11.52	5.44
Foster, C. H	9.10	10.60	5.00
Frye, Rolfe	9.84	11.50	5.71
Glasgow, W. E	9.98	11.43	5.55
Hanson, W. H	9.66	11.31	5.23
Herman, R. S	10.10	11.35	5.55
Hertwig, R	9.97	11.45	5.67
Howard, G. L	10.00	11.50	5.60
Ingman, C. W	9.92	11.45	5.58
Johnson, A. H	9.85	11.44	5.64
Kress, C. B	9.96	11.33	5.75
Lewis, J. P	9.89	11.28	5.49
Long, W. E. (A. W. Meyer)	9.95	11.35	5.55
Mangels, C. E	9.93	11.69	5.56
Mann, M. C	9.70	11.18	5.36
Meyer, W. C	9.44	11.50	5.38
Moen, G	9.80	11.50	5.50
Mize, M. D	9.62	11.20	5.53
Morison, C. B	9.83	11.47	5.49
Murphy, C. M	11.44*	11.00	5.14*
Patton, L. H	9.96	11.51	5.54
Pitts, P. R	9.90	11.34	5.61
Potts, R. B	9.73	11.43	5.42
Richards, W. A	9.70	11.30	5.50
Sasse, A. R	9.66	11.32	5.50
Schlesinger, J	9.75	11.90	5.94
Sherwood, R. H	9.90	11.41	5.40
Sisser, E. J	9.80	11.30	5.60
Spencer, G. L	9.82	11.40	5.39
Swanson, C. O	10.20	11.50	6.30*
Sullivan, Betty	9.93	11.34	5.58
Tibbling, E	9.92	11.30	5.40

*Omitted from averages.

TABLE I—*Continued*

MOISTURE CONTENT OF SAMPLES OF WHEAT, FLOUR, AND BRAN SENT OUT FOR COLLABORATIVE STUDY

All tests made by the 130°C., air, 1-hr. drying, or vacuum oven method. See Cereal Chemistry, Vol. 3, No. 4, pp. 277 and 278.

Collaborators	Per cent moisture		
	Wheat	Flour	Bran
Towner, A. A	9.95	11.65	5.62
Van Scoyk, W. V	9.54	10.88	5.42
Vaupel, H. T	10.03	11.54	5.64
Von Eschen, E. L	9.98	11.33	5.48
Ward, Clarence	9.90	11.40	5.50
Warren, M. R	10.00	11.44	5.63
Weims, G. C	10.20	11.40	5.80
Whitacre, J. W	10.05	11.15	5.75
Whiting, L. D	9.86	11.33	5.49
Wilhoit, A. D	10.00	11.55	5.60
Samples	55	56	52
Average	9.89	11.40	5.54
Maximum	10.20	11.90	5.94
Minimum	9.54	10.88	5.23
Range	0.64	1.02	0.71

Collaborative Studies Regarding Protein Determinations

The same samples used for moisture determinations were used for protein tests. Requests were made that the percentage of protein be determined by the method adopted by the association last year as official (see Cereal Chemistry Vol. 3, No. 4, pp. 261-267), and as a comparison by the method particular to each laboratory. In each instance a complete set of reagents was sent with the samples in order to afford uniformity of results. As a proviso to aid in the interpretation of the results, a small portion of standard sulphuric acid, having a normality of 0.1026 at 23° C. was supplied. A request was made that the normality of this acid be determined.

The results of tests from fifty-eight collaborators are given in Table II. They are not very satisfactory. No better results were obtained by the association method than by any other method. With the wheat, using the association method, the average protein content was 16.29 per cent. The protein content of the flour was 12.53 per cent, and that of the bran, 16.07 per cent. The protein content of the same materials analyzed by the collaborator's own methods was 16.37 per cent for the wheat, 12.53 per cent for the flour, and 16.05 per cent for the bran—on the average, practically no difference by the two methods of study. However, if we confine our analysis to the results obtained by the various collaborators' methods, it will be seen that by the use of the collaborator's own method, 78.4 per cent of the collaborators had results

which ranged between 16.24 and 16.50 per cent, i. e., the average protein content found with the tolerance split two ways. By the use of their own methods, 74 per cent of the collaborators had acceptable checks so far as the protein content of the flour was concerned; whereas, by the use of the same methods only 52 per cent of the collaborators had acceptable protein figures for the sample of bran.

Comparing our analysis next with the collaborators using the association method, it will be seen that only 57 per cent of the collaborators had acceptable checks for the analyses of the sample of wheat. A slightly greater percentage (78) of the collaborators had better results analyzing flour by the association method, whereas, with the sample of bran, close agreements between collaborators was not the rule. Only 48 per cent had acceptable checks with this material as analyzed by the association method.

These differences can not be ascribed to normal solutions because the normality of the standard solutions, as reported by the majority of the collaborators, was well within the values to be expected from cross-titration procedures. Excluding two rather high normalities, the difference in values found by the various collaborators, in terms of protein, would not exceed 0.13 per cent.

Differences in moisture should not have influenced the results, as the samples were all sent out in air-tight containers.

To determine, however, whether this might not be the reason for faulty checking, the results of those collaborators who submitted moisture determinations along with their protein results were calculated to a uniform moisture basis of 13.5 per cent. By this procedure the differences were just as large and in most instances even larger.

The uniformity of the sample was next thought of as a possible reason for lack of better agreement of results. However, before these samples were sent out uniformity was thought to have been assured by noting the moisture and protein content on every fifth container.

As the samples left Washington, the difference in protein content of the samples according to our analyses for any commodity was not greater than 0.15 per cent, whereas the difference in moisture content was less than 0.25 per cent.

TABLE II

PROTEIN FOUND IN SAMPLES OF WHEAT, FLOUR, AND BRAN AS DETERMINED BY COLLABORATOR'S METHOD AND THAT OF THE A. A. C. C.
(See Cereal Chemistry, Vol. 3, No. 4, p. 266.)

Collaborators	Per cent protein by collaborator's method			Per cent protein by A. A. C. C. method			Difference in results by the two methods			Normality of acid found by collaborators
	Wheat	Flour	Bran	Wheat	Flour	Bran	Wheat	Flour	Bran	
Barker, H. C	16.05	12.52	16.31	16.32	12.53	15.66	0.27	0.01	0.65	0.1026
Blish, M. J	16.30	12.48	15.93	16.33	12.45	15.99	.03	.03	.06	.1024
Bliss, F. W	16.40	12.60	16.13	16.40	12.58	16.22	.00	.20	.08	.1031
Briggs, C. H	16.18	12.47	16.08	16.11	12.43	16.06	.07	.04	.02	.....
Carr, Frank	16.28	12.61	16.04	16.36	12.59	16.11	.08	.02	.07	.....
Christie, A	.....	.....	.....	16.16	12.37	15.95	...	...	...	.1026
Collatz, F. A	16.26	12.73	16.50	16.60	12.68	16.36	.34	.05	.14	.1025
Craik, A. P	.....	.....	.....	16.41	12.60	16.25	...	...	...	.1015
Curtis, A. E	16.10	12.40	15.90	16.29	12.49	16.04	.19	.09	.14	.1028
Davis, C. F	16.15	12.54	15.95	16.26	12.58	16.16	.11	.04	.19	.....
Dixon, H. B	.....	.....	.....	16.19	12.37	15.98	...	...	...	.1026
Durham, R. K	16.34	12.36	16.02	16.40	12.42	16.04	.06	.06	.02	.1020
Fellows, H. C	.....	.....	.....	16.16	12.28	15.92	...	...	...	.1026
Fine, H. S	16.07	12.51	15.76	16.01	12.51	15.86	.06	.00	.10	.1058
Flohil, J. F	.....	.....	.....	16.04	12.62	15.91	...	...	...	.1020
Foster, C. H	16.56	12.83	16.41	16.60	12.77	16.41	.04	.06	.00	.1044
Frye, R	16.40	12.51	16.19	16.43	12.59	16.19	.03	.08	.00	.1038
Glasgow, W. E	16.65	12.60	16.45	16.27	12.48	16.35	.38	.12	.10	.1025
Hanson, W. H	15.79	12.37	15.75	15.81	12.51	15.56	.02	.14	.19	.1019
Herman, R. S	16.52	12.57	16.05	16.40	12.53	16.16	.12	.04	.11	.1029
Hertwig, R	16.28	12.43	15.94	15.87	12.46	15.90	.41	.03	.03	.....
Howard, G. L	16.24	12.64	15.97	16.20	12.58	16.16	.04	.06	.19	.1035
Ingman, C. W	.....	.....	.....	16.40	12.50	16.06	...	...	...	.1025
Joslin, H. M	16.19	12.48	16.00	.....	.....	.....	...	...	...	.....
Johnson, A. H	16.42	12.68	16.12	16.47	12.61	16.12	.05	.07	.00	.1027
Karbach	16.23	12.56	16.10	16.39	12.50	16.10	.16	.06	.00	.1020
Kress, C. B	.....	.....	.....	16.30	12.45	16.00	...	...	...	.1024
Lewis, J. P	16.44	12.61	16.18	16.44	12.69	16.18	.00	.08	.00	.1027
Long, W. E	16.36	12.70	16.19	16.54	12.63	16.27	.18	.07	.13	.1026
Mangels, C. E	16.47	12.54	16.25	16.42	12.54	16.25	.05	.00	.00	.1057
Mann, M. C	16.04	12.28	15.56	16.20	12.28	15.66	.16	.00	.10	.1026
Meyer, W. C	16.23	12.42	16.01	16.26	12.43	16.02	.03	.01	.01	.1014
Mize, M. D	16.24	12.48	16.04	16.09	12.28	15.69	.13	.20	.35	.1027

TABLE II—*Continued*

PROTEIN FOUND IN SAMPLES OF WHEAT, FLOUR, AND BRAN AS DETERMINED BY COLLABORATOR'S METHOD AND THAT OF THE A. A. C. C.
(See Cereal Chemistry, Vol. 3, No. 4, p. 266.)

Collaborators	Per cent protein by collaborator's method			Per cent protein by A. A. C. C. method			Difference in results by the two methods			Normality of acid found by collaborators
	Wheat	Flour	Bran	Wheat	Flour	Bran	Wheat	Flour	Bran	
Moen, G	16.48	12.67	16.25	16.47	12.60	16.17	.01	.07	.08	.1024
Murphy, C. M	16.29	12.56	16.01	16.41	12.54	16.27	.12	.02	.26	.1022
Patton, L. H	.....	.....	.....	16.20	12.60	16.35	...	...	...	.1022
Pitts, P. R	16.28	12.50	16.09	16.30	12.50	16.08	.02	.00	.01	.....
Potts, R. B	16.32	12.47	15.84	16.40	12.53	15.91	.08	.06	.07	.1020
Richards, W. A	16.47	12.52	15.96	16.42	12.56	15.90	.05	.04	.06	.1026
Rosse, M. C	15.88	12.69	15.68	15.72	12.69	15.68	.16	.00	.00	.....
Sasse, A. R	16.45	12.55	15.89	16.46	12.58	16.10	.01	.03	.21	.1040
Schlesinger, J	16.24	12.49	15.87	16.35	12.54	16.00	.11	.05	.13	.1002
Sherwood, R. C	16.43	12.65	16.28	16.46	12.60	16.31	.03	.05	.03	.1025
Sisser, E. J	16.35	12.61	16.36	16.35	12.61	16.36	.00	.00	.00	.1019
Spencer, G. C	16.19	12.31	16.11	.....	.....	.....	...	...	...	.....
Swanson, C. O	.....	.....	.....	16.30	12.60	15.96	...	...	...	.1011
Sullivan, Betty	16.41	12.53	16.15	16.05	12.42	16.41	.36	.11	.26	.1024
Tibbling, E	16.50	16.02	16.02	16.48	12.57	16.03	.02	.08	.01	.1027
Towner, A. A	16.20	12.29	15.75	16.37	12.53	15.93	.17	.24	.18	.1011
Van Scoyk, W. V	16.35	12.60	16.10	16.31	12.47	16.13	.04	.13	.03	.1016
Vaupel, H. T	16.19	12.48	15.97	16.01	12.60	16.01	.18	.12	.04	.1019
Von Eschen, E. L	16.38	12.58	15.99	16.43	12.56	16.16	.05	.02	.17	.1022
Ward, Clarence	16.24	12.69	16.10	16.40	12.60	16.27	.16	.09	.17	.1015
Warren, M. R	16.31	12.56	16.05	16.19	12.46	15.87	.12	.10	.18	.1020
Weims, G. C	16.40	12.35	16.12	16.35	12.49	16.09	.05	.05	.03	.1025
Whitacre, J. W	16.15	12.45	15.92	16.28	12.57	15.85	.13	.12	.07	.0995
Whiting, L. D	.....	.....	.....	15.90	12.37	15.93	...	...	...	.1001
Wilhoit, A. D	16.60	12.70	16.33	16.50	12.70	16.30	.10	.00	.03	.1027
Wilkins, H	16.19	12.44	16.10	16.35	12.52	16.15	.16	.08	.05	.1018
Woolsey, Floyd	16.16	12.48	15.90	16.44	12.76	16.28	0.28	0.28	0.38	.....
U. S. Bureau of Standards at 23°C	.....	.....	.....	.....	.....	.....	...	...	...	0.1026
Samples	50	50	50	58	58	58				
Average	16.37	12.53	16.05	16.29	12.53	16.07				
Maximum	16.65	12.83	16.50	16.60	12.69	16.41				
Minimum	15.79	12.28	15.56	15.72	12.28	15.56				
Range	0.86	0.55	0.94	0.88	0.41	0.85				

The only other sources of error which are suggested are digestion and distillation. Losses of protein can be explained by faulty technic incident to digestion, whereas gains in protein can be explained only by faulty technic in distillation.

Frankly, it is impossible to explain the cause of the differences.

Recommendations Regarding Protein

It is recommended that the method adopted for making protein tests be given even more intensive study next year, paying particular attention to points relative to distillation and digestion as possible sources of error.

Collaborative Studies Regarding Flour Ash Determinations

Collaborative studies on flour ash were confined to the two methods adopted by the association at the last convention (Cereal Chemistry, Vol. 3, No. 4, pp. 275 and 276). The only modification made in these methods is that in Method B it was recommended that the glycerol-alcohol solution be allowed to remain in contact with the flour for about 10 minutes before inserting it in the muffle; also, the glycerol-alcohol mixture should be ignited before inserting the crucible in the muffle.

As material for study, five flours were chosen—a straight and a first clear soft red winter wheat flour and two first clear hard red winter wheat flours. These flours were numbered 1 to 5 inclusive.

Sixty-five sets of samples were sent out and returns were obtained from fifty-two collaborators. These results are given in Table III. It will be seen from Table III that the average percentage of ash obtained by either method was nearly the same, the glycerol method yielding slightly higher results throughout. This difference, however, is in the third decimal place.

If we accept the average of all the tests as the correct ash content of the various flours, and then apply the 0.02 per cent tolerance as voted on by this association as an acceptable difference in making ash determinations, it will be seen by Method A that approximately 70, 70, 74, 82 and 88 per cent of all collaborators obtained satisfactory results ashing samples 1, 2, 3, 4, and 5, respectively. With Method B, the results were not quite so satisfactory as only 70, 67, 66, 76, and 60 per cent of the same collaborators obtained satisfactory agreement of results.

TABLE III

ASH CONTENT OF SAMPLES OF WHEAT FLOUR SENT OUT FOR COLLABORATIVE STUDY

Samples were ashed according to Method A and Method B, as described on pages 275-276, Cereal Chem. Vol. 3, No. 4.

Collaborators	Ashed by method A					Ashed by method B					Difference				
	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Bailey, C. H	0.483	0.685	0.556	0.590	0.559	0.484	0.686	0.559	0.591	0.559	+0.001	+0.001	−0.003	+0.001	0.000
Bailey, L. H	.473	.696	.556	.584	.555	.480	.695	.556	.589	.557	+.006	−.001	.000	+.005	+.002
Barker, H. C	.447	.687	.527	.578	.550	.463	.667	.510	.587	.540	+.016	−.020	−.017	+.009	−.010
Bliss, F. W	.470	.680	.540	.580	.550	.460	.660	.530	.580	.550	−.010	−.020	−.010	.000	.000
*Carr, Frank	.463	.666	.566	.573	.558	.523*	.711*	.596*	.593*	.588*					
Christie, A	.487	.692	.555	.585	.553	.477	.691	.555	.585	.555	−.010	−.001	−.000	−.000	+.002
Collatz, F. A	.483	.693	.560	.587	.560	.480	.693	.560	.587	.560	−.003	.000	.000	.000	.000
Craik, A. P	.465	.676	.543	.580	.546	.477	.681	.545	.575	.556	+.012	+.005	+.002	−.005	+.010
Curtis, A. E	.473	.697	.555	.583	.560	.473	.700	.560	.590	.583	.000	+.003	+.005	+.007	+.023
Davis, C. F	.474	.691	.559	.573	.544	.488	.701	.562	.592	.566	+.014	+.010	+.003	+.019	+.022
Dixon, H. B	.480	.692	.552	.585	.556	.482	.693	.555	.588	.557	+.002	+.001	+.003	+.003	+.001
Fellows, H. C	.473	.679	.553	.579	.556	.481	.684	.557	.585	.563	+.008	+.005	+.004	+.006	+.007
Fisher, V. E	....	....	....	....	....	.462	.682	....	.570	.555	....	....	....	....	....
Flohil, J. T	.488	.695	.555	.585	.568	.495	.692	.556	.592	.555	+.007	−.003	−.001	+.007	−.013
Foster, C. B	.480	.695	.560	.585	.560	.480	.690	.560	.580	.555	.000	−.005	.000	−.005	−.005
Frye, Rolfe	.460	.677	.534	.578	.548	.476	.694	.555	.582	.561	+.016	+.017	+.021	+.004	+.013
Glasgow, W. E	.468	.676	.546	.584	.546	.482	.774*	.570	.588	.566	+.014*	....	+.024*	+.004*	+.020*
Hall, W. E	.460	.671	.476*	.516*	.486*	.466	.650	.555	.507*	.526	.006*	−.021*	....	−.009*	....
Hanson, W. H	.483	.698	.563	.573	.548	.465	.688	.568	.585	.548	+.018	−.010	+.005	+.012	.000
Herman, R. S	.470	.685	.558	.582	.555	.475	.673	.557	.585	.558	+.005	+.012	−.001	+.003	−.003
Hogan, J. M	.481	.683	.551	.588	.561	.484	.698	.555	.603	.558	+.003	+.015	+.004	+.015	+.003
Howard, G. L	.475	.688	.552	.583	.554	.472	.690	.552	.585	.559	−.003	+.002	.000	+.002	+.005
Johnson, A. H	.484	.692	.554	.587	.553	.466	.679	.555	.570	.545	−.018	−.013	+.001	−.017	−.008
Johnson, H. H	.459	.668	.527	.556	.538	.458	.645	.541	.571	.549	−.001	−.023	+.014	+.015	+.011
Kress, C. B	.473	.686	.556	.580	.563	.480	.690	.565	.596	.560	+.007	+.004	+.009	+.016	−.003
Kufeld, R	.485	.696	.551	.573	.546	.503	.705	.554	.583	.570	+.018	+.009	+.003	+.010	+.024
Long, W. E	.464	.670	.544	.568	.544	.476	.688	.564	.582	.568	+.012	+.018	+.020	+.014	+.024
*Maney	.461	.657	.483	.557	.517	.465	.657	.576	.553	.530					
Mangels, C. E	.473	.689	.548	.577	.549	.472	.688	.547	.581	.551	−.001	−.001	−.001	+.004	+.002
Mann, M. C	.475	.697	.555	.565	.555	.475	.690	.550	.560	.550	.000	−.007	−.005	−.005	−.005
Meyer, W. C	.470	.673	.545	.587	.560	.476	.683	.553	.590	.570	+.006	+.010	+.008	+.003	+.010

TABLE III—*Continued*

ASH CONTENT OF SAMPLES OF WHEAT FLOUR SENT OUT FOR COLLABORATIVE STUDY

Samples were ashed according to Method A and Method B, as described on pages 275-276, Cereal Chem. Vol. 3, No. 4.

Collaborators	Ashed by method A					Ashed by method B					Difference				
	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
Mize, M. D	.455	.666	.563	.573	.548	.485	.668	.568	.585	.548	+.030	+.002	+.005	+.012	.000
Moen, G	.480	.690	.565	.590	.575	.475	.695	.575	.600	.580	−.005	+.005	+.010	+.010	+.005
†Morison, C. B	.478	.688	.544	.580	.546										
Patten, L. H	.482	.687	.548	.580	.552	.485	.693	.560	.583	.557	+.003	+.006	+.012	+.003	+.005
Pitts, R. H	.477	.685	.541	.581	.545	.470	.683	.558	.570	.548	−.007	+.002	+.017	+.011	+.003
Potts, R. E	.470	.688	.534	.584	.554	.476	.688	.540	.584	.560	+.006	.000	+.006	.000	+.006
Richards, W. A	.480	.697	.563	.589	.567	.484	.700	.573	.600	.573	+.004	+.003	+.010	+.011	+.006
Rogers, C. R	.470	.676	.539	.580	.549	.474	.674	.540	.550	.533	+.004	+.002	+.001	−.030	−.016
Rosse, M. C	.471	.679	.558	.494	.556	.470	.686	.555	.481*	.556	−.001	+.007	−.003	....	.000
Schlesinger, J	.477	.684	.553	.575	.553	.480	.696	.561	.591	.564	+.003	+.012	+.008	+.016	+.011
Sherwood, R. C	.470	.687	.557	.583	.553	.483	.698	.577	.597	.573	+.013	+.011	+.020	+.014	+.020
Skovholt, Oscar	.477	.690	.557	.563	.545	.485	.680	.540	.570	.553	+.008	−.010	−.017	+.007	+.008
Shiple, V	.479	.693	.559	.581	.550	.475	.694	.558	.582	.556	−.004	+.001	−.001	+.001	+.006
Sisser, E. J	.500	.700	.550	.580	.550	.495	.695	.545	.575	.545	−.005	−.005	−.005	−.005	−.005
Sullivan, Betty	.480	.693	.550	.575	.563	.485	.685	.560	.585	.560	+.005	−.008	+.010	+.010	−.003
Towner, A. A	....	....	....	....	....	.476	.686	.550	.580	.550	....	....	....	....	....
Ulrey, E. L	.487	.715	.546	.565	.542	.486	.704	.552	.568	.551	−.001	−.011	+.006	+.003	+.009
Van Scoyk, W. V	.480	.697	.557	.580	.557	.457	.680	.553	.577	.540	−.023	−.017	−.004	−.003	−.017
Vaupel, H. F	.494	.695	.564	.562	.547	.490	.697	.580	.590	.570	−.004	+.002	+.016	+.028	+.023
Ward, Clarence	.474	.690	.540	.570	.550	.483	.683	.533	.567	.550	+.009	−.007	−.003	−.003	.000
Werner, E. E	.475	.685	.545	.579	.551	.484	.696	.556	.590	.564	+.009	+.011	+.011	+.011	+.013
Whiting, L. D	.473	.693	.556	.593	.563	.470	.693	.560	.590	.570	−.003	.000	+.004	−.003	+.007
Whitacre, J. W	.476	.680	.570	.576	.553	.480	.686	.566	.583	.556	+0.004	+0.006	−0.004	+0.007	+0.003
Wiens, G	.490	.710	.533	.570	.533	....	....	....	....	....	....	....	....	....	....
*Wilhoit, A. D	0.530	0.700	0.605	0.630	0.600	0.500	0.700	0.537	0.580	0.540	....	....	....	....	....
Samples	52	52	51	50	51	52	51	51	50	52					
Average	0.475	0.687	0.551	0.579	0.553	0.478	0.687	0.555	0.583	0.557					
Maximum	.500	.715	.570	.593	.575	.503	.704	.577	.603	.580					
Minimum	.447	.666	.527	.562	.533	.462	.645	.510	.560	.526					
Range	0.053	0.049	0.043	0.031	0.042	0.041	0.059	0.067	0.043	0.054					

*Omitted from averages.

†Results with Method B unsatisfactory.

It may be worth while to point out here why the glycerol-alcohol method is being studied as an alternate ash method. It has been the experience of all analysts, no doubt, that some flours are more difficult to ash than others. With some flours, even at a high temperature, it is impossible to rid the ash entirely of the last traces of carbon. With some flours also the ash will aggregate into a small hard mass, richly impregnated with carbon. Glycerol-alcohol prevents the occurrence of these two conditions and seems to be of decided advantage for use with flours which are difficult to ash.

It was hoped that there would be difficulty in ashing the flours sent out for collaborative ash work, but apparently this was not the case.

Recommendations Regarding Ash Determinations

It is recommended that further study be given to the glycerol ash method on flours which are known to give serious ashing difficulty in order to obtain further data on its value as a method to use with these flours.

Collaborative Studies Regarding Glutenin Determinations

Three methods were studied for making glutenin determinations on wheat flour, namely, the Sharp and Gortner indirect method, the shorter Blish and Sandstedt method, and the recently published method of Blish and his associates, the barium hydroxide method.

The results obtained by these methods are given in Table IV. Both samples of flour analyzed were straight grade flours of the hard red winter wheat class. The results are not all that are to be desired and it is believed that part of the differences may be explained by the difficulty experienced in making protein determinations. This is apparent especially with Sample 1, in which a difference in protein content of 0.85 per cent was found by the ten collaborators. Lacking closer agreements on the original material before being subjected to test, it is reasonable to suppose that irregular results will be obtained when the separation proper is being carried into effect.

Recommendations Regarding Glutenin Determinations

It is recommended that study be carried forward another year before any recommendations are given regarding the adoption of a method for determining the glutenin content of wheat.

TABLE IV

COMPARISON OF METHODS FOR MAKING GLUTENIN DETERMINATIONS ON WHEAT FLOUR

Collaborator	Protein in flour		Blish and Sandstedt*		Barium hydroxide†		Sharp and Gortner‡	
	Sample No. 1	Sample No. 3	Sample No. 1	Sample No. 3	Sample No. 1	Sample No. 3	Sample No. 1	Sample No. 3
	%	%	%	%	%	%	%	%
Bailey, C. H. for W. P. Sinclair	14.08	8.20	4.50	2.58	5.00	2.57		
Blish, M. J.	14.51	8.12	5.58	3.19	5.49	3.51	5.00	3.13
Coleman, D. A.	14.23	7.95	5.13	2.83	5.45	3.28	5.15	3.28
Christie, A.	14.27	7.94	5.15	2.91	5.35	3.27	....	....
Dixon, H. B.	14.46	8.05	4.84	2.73	5.55	3.57	....	....
Fellows, H. C.	14.34	7.98	5.12	2.93	5.21	3.22	5.26	3.05
Mangels, C. E.	14.93	8.21	5.26	2.88	5.58	3.31	....	....
Morison, C. B.	14.64	8.27	4.94	2.72	5.98	3.62	....	....
Sherwood, R. C.	14.68	8.08	5.38	3.35	5.41	3.32	....	....
Whiting, L. D.	14.36	8.10	....	....	5.18	3.32	....	....
Average	14.45	8.07	5.10	2.94	5.41	3.30	5.14	3.15
Maximum	14.93	8.27	5.58	3.35	5.98	3.51	5.26	3.28
Minimum	14.08	7.94	4.50	2.58	5.00	2.57	5.00	3.05
Range	0.85	0.33	1.08	0.77	0.98	0.94	0.26	0.23

*Blish, M. J. and Sandstedt, R. M. Cereal Chem. Vol. 2, No. 2, pp. 57-67.
†Blish, M. J., Abbott, R. C., and Platenius, H. Cereal Chem. Vol. 4, No. 2, pp. 2[illegible].
‡Sharp, P. F. and Gortner, R. A. Minn. Agr. Exp. Sta. Bull. 19.

Collaborative Results on the Hydrogen-ion Test

The collaborative studies on hydrogen-ion tests were of the same type as last year. Three samples of flour, a patent, a straight, and a first clear, all milled from Montana spring wheat, were sent out with a small amount of potassium and phthalate solution.

The method prescribed was as follows:

Weigh 10 g. of the flour into a 250 cc. Erlenmeyer flask and suspend in 100 cc. of neutral distilled water at a temperature of 25° C. Maintain at 25° C. for 30 minutes, shaking at 5-minute intervals in order to keep the flour particles in suspension. Allow to stand exactly 10 minutes for the flour particles to separate out, and decant the supernatant liquid into the hydrogen electrode vessel, and at once determine the H-ion concentration electrometrically.

Report the H-ion concentration as pH and also indicate any departure from the prescribed procedure, as well as the characteristics of (a) the calomel electrode vessel, (b) the hydrogen electrode vessel, and (c) the potentiometer set-up.

The results are given in Table V. It can be readily seen that the results are not satisfactory. The range in pH found with sample 1 was 0.49, with sample 2, 0.69, and with sample 3, 0.50. On the other hand the range in pH found with the phthalate solution, except by one collaborator, was 0.43. It seems that the equipment

for making the test was just as much at fault in producing such irregular results as was the technic.

Further studies should be made, especially in relation to the type of electrode and the influence of filtering on the final results, before the adoption by the association of any test for hydrogen-ion determination.

TABLE V

COLLABORATIVE TESTS FOR HYDROGEN-ION DETERMINATIONS

Collaborator	H-ion concentration as pH			Potassium acid phthalate solution	Type of H. electrode	Calomel electrode
	Sample No. 1†	Sample No. 2‡	Sample No. 3§			
Bailey, C. H	5.78	5.90	5.88	4.18	Bailey	saturated
Blish, M. J. *	5.71	5.91	6.20	3.96	Bailey	saturated
Dixon, H. B.						
filtered	6.204	6.373	6.338	3.96	Hildebrand	saturated
not filtered	5.805	5.994	6.271	3.96	Hildebrand	saturated
Herman, R. C	6.052	6.188	6.381	4.007	Bailey	saturated
Kress, C. B	5.58	5.78	6.08	3.75	Bailey	saturated
McLaren, L. H	5.968	6.019	6.373	5.664	Hildebrand	saturated

*No filtration.
†Short patent spring wheat.
‡Straight spring wheat.
§First clear spring wheat.

Flour Sampling Activities

The method for sampling flour adopted by this association for study last year has received no action because it has been impossible to secure collaborators. However, through the courtesy of Mr. H. Runkel, associate referee on flour sampling methods for the Association of Official Agricultural Chemists, I am able to present to you some experiments carried out for him by some of the members.

Mr. Runkel had two experiments carried out as follows:

Experiment A—Sack Sampling

To show the accuracy with which the tentative method draws a representative sample from one sack of flour, empty a 49-pound sack of flour into a container large enough to hold all the flour when the container is two-thirds full. Alternately invert and roll the closed container fifty times. Then, by means of a cylindrical pointed, polished steel trier one-half inch in diameter, with a slit of at least one-third of its circumference, draw five cores from the top to the bottom of the flour in the can so as to obtain a thoroly representative sample. Place all five cores in a clean, dry, air-tight container.

Return the flour to the sack and after it is sewed, sample it by drawing one core from one corner of the top diagonally to the center of the sack and a second core from the other top corner of the sack to one-half the distance to the center of the sack. Place both cores in an air-tight container. Determine the moisture on the two samplings at once, using the vacuum method.

Weigh the sack of flour to at least one-fourth of an ounce. Allow it to lie on the floor or table in a warm dry place (60° C. to 75° C. and 45% to 55% relative humidity, similar to an ordinary store room for flour) for seven days and reweigh on the same scales taking the necessary precautions to prevent any sifting. After reweighing, repeat the sampling in the sack, mixing in the can and sampling and determining the moisture as before.

The results obtained in Experiment A are given in Table VI. This table shows the accuracy found by applying the tentative flour sampling method to a single sack of flour. The per cent of moisture reported in the first, third, and fourth columns headed "calculated from weight loss," "flour mixed in closed can," and "resacked flour sampled by tentative method" respectively, should check closely. They represent three separate efforts to arrive at the true moisture content of the sack of flour. The figures in the second column, headed "sack sampled by tentative method," when compared with those in the other three columns show the accuracy of the tentative method when applied to a single sack of flour.

In the experiment reported October 8, 1926, the figures do not check. The figure in the last column "resacked flour sampled by tentative method" checks the calculated moisture. There is a bare possibility that the amount of mixing in the closed can was not sufficient, altho the directions were carefully followed. It is probable that the moisture content of this sack of flour after the last storage period was very close to 11.88%, as shown by the calculated moisture. Assuming that 11.88% is correct, the difference between the correct moisture and the moisture found when the sack was sampled by the tentative method is 0.38%, which appears to be quite large.

In the experiment dated October 4, 1926, the three check determinations given in the first, third and fourth columns are quite uniform. Assuming that the true moisture content is 12.22%, the variation of the moisture when sampled by the tentative method, is 0.38%, which also seems quite large.

TABLE VI

RESULTS OF EXPERIMENT A

(To show accuracy with which tentative method draws a representative sample from one sack of flour)

Sampler	Date	Per cent moisture (Average of triplicate determinations)			
		Calculated from weight loss	Sack sampled by tentative method	Flour mixed in closed can	Resacked flour sampled by tentative method
Runkel*	9-3-26	.....	13.70	13.78	13.65
	9-28-26	12.82	12.82	12.81	12.81
	10-8-26	11.88	12.26	12.16	11.81
Collatz†	9-24-26	.....	.....	.....	.....
	10-4-26	12.22	12.60	12.15	12.22

*Analysis made by M. L. Johnson, of U. S. Food and Drug Inspection Station, Minneapolis, Minn.
†Analysis submitted by F. A. Collatz, Chief Chemist, Washburn Crosby Co., Minneapolis, Minn.

Of this experimental work, the tentative method gave close checks to the actual moisture in two instances, but in the other two the difference was 0.38%, the tentative method giving high results in both cases. While the demonstrated accuracy of the tentative method is not regarded as good, some of the committee question whether any other method of sampling will give more accurate results. Data are meager. The experimental work is rather involved, requires considerable time, and is very susceptible to error. Further data seem desirable before the method is adopted as official.

It is therefore recommended that further collaboration be secured according to Experiment A, using both the tentative method and one other method of drawing cores from the sack, to determine if the accuracy of sampling a single sack of flour can be improved.

Table VII shows the agreement with which two samplers checked by the tentative method. It is believed that this experimentation is not sufficient, as the analyses of the various sacks are fairly uniform throughout the pile. It does not appear that the piles of flour were of sufficient variation to give the method a thoro trial, altho the experimenters endeavored to locate piles of flour which they considered difficult to sample. It is recommended that further collaborative work according to Experiment B be done during the coming year.

Special Investigations

As a result of the ruling by the United States Bureau of Chemistry that flour may now contain 15 per cent of water as determined by the vacuum oven method, and because the official Brown-Duvel method is standardized according to the water-oven method, some have asked if the cut-off temperature for the Brown-

Duvel machine could not be changed so that the results obtained on it would be on the same oven basis as is the new flour moisture basis.

TABLE VII
RESULTS OF EXPERIMENT B
(To show the accuracy with which one sampler may check another by the use of the tentative method on the same pile of flour.)

Location of pile		Per cent moisture*	
	Sack No.	Collatz A.	Collatz B.
Washburn Crosby Mill, Minneapolis, Minn.†	1	13.44	13.50
	2	13.46	13.54
	3	13.48	13.44
	4	13.46	13.52
	5	13.43	13.30
	6	13.46	13.51
	7	13.47	13.40
	8	13.48	13.46
	9	13.40	13.46
	10	13.46	13.46
	Average	13.45	13.46
	Sack No.	Gray "1"	Gray "2"
Pillsbury Mill, Minneapolis, Minn.‡	1	13.36	13.43
	2	13.40	13.36
	3	13.38	13.53
	4	13.39	13.47
	5	13.32	13.35
	6	13.44	13.38
	7	13.35	13.22
	8	13.38	13.45
	9	13.39	13.37
	10	13.38	13.38
	11	13.38	13.38
	12	13.41	13.48
	Average	13.38	13.40
	Sack No.	Garrett	Gill
Duluth Universal Mill, Duluth, Minn.‡	1	13.61	13.53
	2	13.56	13.55
	3	14.18	14.03
	4	13.60	13.55
	5	13.58	13.55
	6	13.62	13.53
	7	13.59	13.55
	8	13.65	13.55
	9	13.62	13.66
	10	13.64	13.62
	Average	13.66	13.61

*Average of triplicate determinations.
†Analysis by F. A. Collatz.
‡Analysis by M. L. Johnson.

Investigations were conducted by the chairman of this committee and the following conclusions were arrived at:

With spring and winter wheat having a moisture content ranging between 9.5 and 16.5 per cent no difficulty was experienced in having the Brown-Duvel machine check with the 130° C., 1 hour, air-oven method, using 190° C. as the cut-off temperature. With some Durum wheats of low moisture content (9.5 to

11.5 per cent), there is some indication of charring, but the difference in moisture by the two methods was not greater than 0.3 per cent.

White wheats offer the most difficulty. Poorer checks and partially charred grain seem to be more often met with in this class of wheat.

It seems, therefore, from the investigations that the Brown-Duvel method for making moisture determinations on wheat can be made to give the same results as the vacuum method on flour if the cut-off temperature of 180° C. now specified is raised to 190° C. This statement is with the proviso that all tests which show a decided discolored distillate should be rejected.

Revision of Book of Methods

It will be remembered that a resolution was passed last year at the Denver convention authorizing the method's committee to undertake the revision and enlargement of the present Book of Methods. Such an assignment has not been an easy one when it is remembered that, outside of such routine determinations as moisture, ash, and protein this organization has no great amount of experimental data to draw on.

It has been necessary, therefore, in making a revision and enlargement of the Book of Methods, after exhausting our own experimental data, to draw on outside investigations of recognized standing. Such a procedure has been undertaken with some temerity because the selection of a suitable method from several for the same purpose is always influenced by the personal equation. In other words, methods that give utter satisfaction in the hands of some become questionable in the hands of others. You have only to refer to the discussion of collaborative work for this year to be fully cognizant of that. However, in accordance with the resolution passed last year, a revision and enlargement of the Book of Methods has been made, and as it now stands it is composed of ten sections with reference tables as shown on the mimeographed sheets which are in your hands.

It is planned to print this book in loose-leaf form so that further revision and insertions can be easily made.

Efforts were made to complete the revision so that the book could be ready in time for this convention. It was found, however, that altho the resolution provided for the actual work of revising the book, it did not provide funds for its printing.

ADDRESS OF THE PRESIDENT

R. J. CLARK
Kansas City, Mo.

(Given at the Convention, May 30, 1927)

In July, 1925, when I extended to you my "greetings" as your new president, one thought was emphasized, i.e., that the association should be made more practical. It requires time to work out many of the problems which involve public opinion, research, or association welfare. Just how practical have been our accomplishments during the last two years of organization endeavor can best be judged by future cereal chemists. It is enough for me to say that your officers and committee members have worked hard and can with clear consciences render their reports with "I have fought a good fight, I have kept the faith."

History, to many, is dull, especially when its events are still fresh in our minds. The News Letters have carried to you the important happenings of our association life, much better than they can here be retold. Two years ago we spoke of a new book of revised methods that was to come. Now the manuscript is ready for the printer. Two years ago the baking procedure, so far as unity of thought was concerned, was considered a joke. Tomorrow, with new light on this perplexing problem, our baking committee will outline to us its decision on the subject. Final? No, but it is a start and that is infinitely more than any organization has yet accomplished; and far more than we ourselves accomplished until recent years. As was predicted in our Denver meeting, the four hours devoted to the discussion on experimental baking did more to arouse association interest, point out the humps on our own backs, and cement convictions than a dozen papers of masterly thought and research.

Our secretary informs me that fifty-eight chemists have joined our ranks during the last year—the largest increase the organization has enjoyed in a like period since its inception. Much credit for this increase is due the membership committee. Does this not argue that our association is in a healthy condition? I might continue to enumerate and comment upon our accomplishments—the organization and chartering of local sections, the awarding of a medal for distinguished service in this field—but present duties and future needs should receive more attention. Let us not grow

too proud with past glory lest we forget that growth lies in accomplishment, in the getting and not the possession.

Our present situation is familiar to even more than our past. It is so bound with our future that I wish to treat the two together. Numerically, we are enjoying a steady growth which points to lasting endurance rather than the mushroom sprouting which withers and dies over night. To be sure, we lose many members each year for various reasons, but when the sifting is completed the roll shows each time a net gain. Let us not resort to drives, to reduced entrance requirements, to modified dues or other inducements to attract numbers. If the quality of our service and the standard of our standing remain fixed or are moved even higher, we shall attract and build much more permanently.

Financially, altho our bank balance is several thousand dollars, we are embarrassed. Most of this money belongs in the surplus reserve fund for Cereal Chemistry. It is needed and rightfully belongs in this fund. Money to carry on association activities is sadly needed. It was planned in Denver to issue six News Letters during the year; but finances permitted only three and the last one of a single sheet. Your officers should visit the various sections to strengthen the organization and keep in touch with the common thought. This has been impossible during the last year, especially because no expenses for traveling could be allowed. Committee work, especially that of the baking committee, was curtailed because no funds were available. It takes money to publish Cereal Chemistry, it takes money to carry on the work of the association. We have no paid officers, so all the treasury money goes for running expenses. Two years ago the entrance fee or initiation fee of $5.00 was dropped in order that students of limited means might join our organization. No provision was made to reimburse the treasury for this lack of revenue. In order to bring relief to the treasury and render progressive activities possible, I hereby propose the following measures: That our yearly dues be raised to $7.00 effective January 1, 1928; $3.00 of this to be set aside for the Cereal Chemistry fund and constitute our subscription price for that publication; the remaining $4.00 to be used for other association work. During the last year the executive committee was made a budget committee; so I suggest that the expenditure of this remaining $4.00 of the dues be left to the judgment of the executive committee.

Our initiation fees were removed several years ago for the sole reason that students of limited means could not join because

the required first year's dues and entrance fees totaled too much. Not all our members come to us as students. In fact, a really small percentage of our membership has joined while in school. I have no prejudice against the student belonging to our association on the same footing as the professional man of business. The encouragement a student receives by association with older members is conducive to good work. The help the older member receives (in helping to direct the interests of the student) more than compensates him through the service he renders in generally strengthening his own profession. I am convinced that students should be encouraged while in their formative years to join their professional societies. In view of our own financial situation and as an inducement to students to become association members before graduation, I wish to submit this plan for your consideration. Whenever a professor proposes the name of a student in accordance with the rules of our constitution as a member, that said student be admitted to membership without initiation fees; all other persons desiring membership to be admitted upon a $3.00 admittance fee. This proposal, in conjunction with my previous proposal, would mean that in case of non-students $10 would be charged; $7.00 of which constituted the first year's dues to be divided as mentioned, namely $3.00 as a subscription to Cereal Chemistry and $4.00 to the general treasury; the remaining $3.00 to be the initiation fee and go to the general treasury.

In the Denver meeting last year, it was decided to award a medal for distinguished service in this field; but no method of financing this move was made. We have a division of membership on our roll known as "Corporation members." Their dues are at present $10, and all the money is allotted to the Cereal Chemistry fund. The firms thus contributing do so through a willingness to support the work of the association. I believe they would feel more kindly toward our organization if they knew their money was used, not for the current running expenses of any one department of association activity, but for some permanent, lasting purpose. I therefore recommend that all the dues of Corporation members (except the regular $3.00 subscription rate for Cereal Chemistry) be permanently invested and the interest from this fund be used to have the Osborne medal made whenever the medal committee deems the award should be presented. As the years pass, the fund will grow to the point where the interest will bear the expenses of the medal recipient to our convention, and later it may become large enough to warrant a monetary award as well as the gold medal.

Action was taken during our Denver convention authorizing the chairman of our methods committee to revise and have printed our book of methods. He has the manuscript ready for the printer. The convention did not, however, authorize an appropriation for financing this publication. In order to make possible such a compilation of methods, I suggest that advance literature be sent each member describing the contents of the book, its value to the chemist, and enclosing subscription blanks; that advance subscriptions be made by the members of our association, based upon an estimated price furnished by the printers, with the understanding that if (after printing the book) it is found the cost per volume is less than the subscription price, the difference be returned to the subscriber; and that the difference between the sum collected through subscriptions and the price of publication be guaranteed by the association.

During the last year charters were granted to four local sections. Some of these sections have a chairman and secretary but no other officers. I would suggest that each local section consider an organization similar to our national association, i. e., a chairman, a vice-chairman (who shall be chairman of the local executive committee), and a secretary-treasurer. In other words, we need more complete organization among our sections. We should encourage the formation of more sections as well as the strengthening and encouraging of those already formed.

This association has for several years chosen its convention cities by a mail ballot. This requires considerable work and expense. The time consumed in waiting for the ballots to be returned could be more efficiently used in planning the next convention, if the location had been previously named. For instance, during the last year, the ballots were sent out in August. They were not returned until late in September. Announcement of Omaha as the convention city and the appointment of the local committee could not be made until the time of the Kansas City symposium, the last of October. This greatly delayed the work of the program committee. Usually those who attend our convention are more interested in association work and have the association work more at heart than those who stay at home. I therefore propose that hereafter our future convention city be decided upon before the close of each convention. This could be done by having cities nominated from the floor and the city receiving the majority of the votes cast would become the meeting place for the next year.

There is a tendency on the part of some schools to place their graduates in the highest positions obtainable. This seems to be especially true of chemists going into cereal work. I have known many men in the last few years who, upon graduation, stepped into flour mills as chief chemists. I have watched with interest the progress made by these men. Their school work had been far above reproach, they were all exceptional scholars, so that they as well as their professors believed an excellent opportunity had been seized when the graduate secured a position as chief chemist. What was the result? Each one of these men has, at this time, made a failure of his cereal job. If that were the only result it would be easily rectified, but the effect is far more detrimental. The firms for which these men worked lost faith in cereal chemistry and it will take years to regain their lost confidence. Our profession loses much of its standing by such mistakes.

Cereal chemistry is not all wrong because some men fail. Theoretical practice of the schoolroom and industrial practice of commerce are related, but not synonymous. No college graduate, even tho he carries a Ph.D. degree, should make his first job that of chief chemist, no matter how small the mill or how small the chief's job may be. That graduate usually has "ego" stamped in boldfaced type on his person. Before he can make the success he thinks he is, he must realize that the world has run hundreds of years before he came into power and it will continue to run when his deeds are forgotten.

The best way to eradicate such human tendencies is for the graduate to enter the laboratory of the largest concern he can locate. He may run proteins all day, he may burn ash all night, or he may only wash test tubes; but if he has real material in him he will absorb in three or four years the business man's requirement of and definition for a chemist. He will see that theories and pictures belong in the industrial laboratory only if they can be made practical and turned into money. Having served his apprenticeship in the commercial laboratory under an efficient chief, he can move out under his own initiative and become a chief himself. Electrical engineers have their Westinghouse, General Electric, or Bell Telephone; lawyers their senior partners; doctors their internships; and cereal chemists should serve their apprenticeship in an industrial laboratory. Schools and professors who ignore this principle only bring eventual discouragement upon their graduates and reflection upon their institutions. I strongly urge that this association endorse the plan of cereal apprenticeship for college graduates;

and discourage, by its influence, the placing of recent graduates in positions of responsibility requiring industrial experience.

In conclusion, I wish to present for the consideration of this assembly the following recommendations:

1. That the membership dues be raised to $7.00 per year, to be divided as follows: $3.00 for a subscription to Cereal Chemistry and $4.00 for the general association treasury; the expenditure of said $4.00 to be subject to the approval of the Budget Committee.
2. That students who pass the entrance qualifications be admitted to association membership upon payment of $7.00; but all other applicants be charged an initiation fee of $3.00, making the payment which accompanies their application blank $10.
3. That $7.00 of each corporation membership fee of $10 be invested each year in a fund known as the Osborne Medal Fund; that the interest from this investment be used to pay for the gold medal, when it is awarded; that any surplus interest money be used to defray the traveling expenses of the medal recipient; and that when the fund becomes large enough to pay for making the medal and bearing the expenses the surplus be used as a monetary award to accompany the medal.
4. That a plan be outlined for financing the publication of our book of methods. I suggest that advance subscriptions be solicited from our members and the difference between the sum thus raised and the cost of printing be guaranteed by the association, until the books can be sold and the money realized; that if the actual cost per volume is less than the subscribed price, the difference be returned to the subscriber.
5. That the sections of the association strengthen their local organizations and pattern them after the national association.
6. That our next convention city be chosen by vote each year during our annual meeting, instead of by a mail ballot.
7. That the association use its influence to discourage the practice of college graduates stepping into chief chemist positions until they have served a reasonable apprenticeship in a large industrial laboratory, and go on record to this effect.

MINUTES OF THIRTEENTH ANNUAL CONVENTION OF THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS

By R. K. DURHAM, Secretary-Treasurer

Fontenelle Hotel, Omaha, Neb.
May 30 to June 3, 1927

Monday, May 30

Convention called to order at 10:00 a. m. by President R. J. Clark
Invocation by the Reverend John A. Krance
Presidential address by R. J. Clark
Announcements and reading of communications
Paper—"The Work of the Bakery Engineer in Relation to that of the Flour Mill Chemist," by E. B. Price, president of the American Society of Bakery Engineers (In the absence of Mr. Price, the paper was read by L. R. Olsen)
Paper—"Relations Between the Association of Official Agricultural Chemists and the American Association of Cereal Chemists," by Raymond Hertwig
Paper—"What Progress Are We Making as Cereal Chemists," by C. H. Bailey
Appointment of convention committees:
Auditing committee: R. W. Mitchell, Chairman, R. B. Potts
Nominating committee: H. E. Weaver, Chairman, C. G. Harrel, H. J. Fleming
Resolutions committee: L. H. Bailey, Chairman, William L. Haley, Fred J. Lumsden
Moved by Alexander that all appropriation bills be first approved by the executive committee before being brought to the floor of convention. Seconded, carried.
Adjourned at 12:00 m. for lunch in honor of past presidents.
Meeting called to order at 2:00 p. m. by President Clark
Paper—"Interpretation of Experimental Baking Results," by L. W. Haas (In the absence of Mr. Haas, the paper was read by A. W. Meyer)
Paper—"Evaluation of Flour from the Baker's Standpoint," by C. B. Morison.
Paper—"Value of the Laboratory Report to the Flour Buyer," by A. D. Wilhoit
Meeting adjourned at 3:30 p. m.

Tuesday, May 31

Meeting called to order at 9:20 a. m. by President Clark
Paper—"Study of Influence of Size and Shape of Pan on Baking Test," by John T. Lewis and W. O. Whitcomb
General report of Committee on Standardization of the Experimental Baking Test, by M. J. Blish
Sub-reports by L. H. Bailey, Emily Grewe (read by L. H. Bailey), R. C. Sherwood and C. H. Bailey, R. S. Herman, L. D. Whiting, and C. B. Morison
Paper—"Factors Affecting Interpretation of Experimental Baking Tests," by M. J. Blish
Discussion followed on the merits of fixed type baking method as proposed by the committee on standardization of laboratory baking test. In response to the question "How many are using a fixed type method?" a very large percentage indicated in the affirmative except with reference to absorption. The discussion was not very brisk so, to bring the question to a vote, Mangels moved that the association accept the report of Dr. Blish,

which would infer that we go on record as favoring the fixed type of baking test. Seconded, carried. Further discussion followed.

Meeting adjourned at 12:00 m.

Meeting called to order at 2:20 p. m. by President Clark

Paper—"An Automatic Proof Box," by C. G. Harrel

Paper—"A Gravimetric Penetrometer for Determining the Stiffness of Doughs," by C. G. Harrel

Discussion on baking committee report continued from the morning session. It was brought out that the fixed method should not include a fixed amount of water but rather a fixed or workable stiffness for consistency of dough. Also brought out that flour should be weighed on a definite moisture basis.

Moved by Gortner that if committee send out directions for collaborative work, amount of flour to be used be stated on a dry basis. Seconded, lost, it being consensus of opinion that all details should be worked out by the committee.

Moved and seconded to adjourn. Lost.

Further discussion regarding standard baking brought out that the method thus far used by the baking committee may or may not be presented for approval, depending on future work of the committee.

Moved and seconded that meeting adjourn. Carried. Meeting adjourned at 4:20 p. m.

Wednesday, June 1

Meeting called to order at 9:00 a. m. by President Clark

Moved by C. H. Bailey that minutes of previous convention as published in Cereal Chemistry be approved. Seconded, carried.

Reports of officers

Report of secretary-treasurer, R. K. Durham

ANNUAL REPORT OF THE SECRETARY-TREASURER OF THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS

By R. K. Durham

May 28, 1927

Your secretary-treasurer again brings to you a favorable report, particularly that portion concerning growth in membership. Ninety-two new members have been added during the fiscal year, an increase of 31 per cent. Unfortunately however, 34 members have resigned or have been suspended for nonpayment of dues. The turnover is large, too large when one considers that most of those retired from membership remain active in cereal chemistry. In spite of the large number of names removed from the list, we are able to show a net gain of 60 members, or 20 per cent. This just about equals last year's gain.

The financial showing is not so encouraging. Only by practicing rigid economy, were we able to show a small gain in net worth for the fiscal year. To do this it has been necessary for the officers, in addition to giving their time for thought and detail work, to do much of their own stenographic work. The News Letter, the medal award, and the book of methods, all recently added financial burdens, together with other proposed activities, are leading to the necessity for greater revenue. It is true that the financial statement shows a fairly large reserve, but such a reserve is necessary if the organization is to remain in sound condition. Furthermore, the reserve fund is practically all credited to Cereal Chemistry, and is not available for other association activities. It seems we are rapidly approaching the time when a reasonable increase in membership dues will be a necessity if we are to carry on the various projects now being undertaken and those which are under consideration.

The element of convenience was allowed to play too great a part in the selection of a bank as depository for association money. The Intercity State Bank, with whom we had been connected for about four years, was forced to close its doors on December 29 following a slow run. Your secretary-treasurer was not entirely ignorant of the bank's condition in the last few days of its existence. Preparations had been made to withdraw the account, but time consumed in sending checks to Minneapolis for the vice-president's counter-signature proved unfortunate. The bank has advised that the first dividend will be paid early in June and that we can reasonably expect to recover the entire amount on deposit. Final statement rendered by the defunct bank shows a balance of $632.51. In the financial statement given below this amount is included in cash in bank altho it is really not available as such.

In accordance with a motion passed at the last convention, charters have been granted to all local sections making application and furnishing satisfactory evidence that all officers and at least 75 per cent of the members were members of the A.A.C.C. Four charters have been applied for and granted.

Charter certificate No. 1 was issued to the Northwest Cereal Chemists Club under the name Northwest Section of the A.A.C.C.

Charter certificate No. 2 was issued to the Kansas Chemists Round Table Club under the name Pioneer Section of the A.A.C.C.

Charter certificate No. 3 was issued to the Kansas City Protein Referee Board under the name Kansas City Section of the A.A.C.C.

Charter certificate No. 4 was issued to the Nebraska Cereal Chemists Club under the name Nebraska Section of the A.A.C.C.

Financial Statement

RECEIPTS			
Cash on hand May 28, 1926		$ 7.60	
Membership dues		2244.00	
Subscriptions, reprints, back numbers		1375.74	
Advertising in Cereal Chemistry		1080.00	
Interest on Building and Loan stock		140.08	
Sale of Building and Loan stock		1000.00	
Miscellaneous receipts		5.58	
Total receipts			$5853.00
DISBURSEMENTS			
1926 convention expense		$ 155.83	
Auditing treasurer's books		25.00	
Printing Cereal Chemistry and reprints		2817.24	
Proofreading Cereal Chemistry		250.00	
10% commission on advertising		120.00	
Misc. expense in editing Cereal Chemistry		396.64	
Printing and mailing News Letter		99.10	
Office supplies for officers		76.17	
Stenographic hire for officers		173.25	
Postage for officers		55.98	
Misc. officers expense		16.95	
Gift to secretary-treasurer		200.00	
Purchase of Building and Loan stock		500.00	
Total disbursements			$4886.16
Cash on hand May 28, 1927			966.84
Assets			
Imprest fund, Minneapolis		$ 100.00	
Cash in bank			
Inter-city State Bank	$ 632.51		
First National Bank	792.84		
		1425.35	

Cash on hand but not deposited		36.48	
Building and Loan stock		2500.00	
Accounts receivable—advertising			
Central Scientific Co	36.00		
Despatch Mfg. Co	45.00		
Kansas City Lab. Supply Co	22.50		
Wallace & Tiernan	18.00		
Fontenelle Hotel	10.00		
Thermo Electric Instrument Co	27.00		
Total accounts receivable		158.50	
Total assets			$4220.33
Liabilities			
Loan—Stanford Food Research		$ 200.00	
Checks issued but not presented for payment		494.99	
10% commission on May advertisements		19.00	
Total liabilities			713.99
Net worth at May 28, 1927			$3506.34

Detailed Membership Statement

	Active and Associate	Corp.	Honorary	Total
Membership, May 28, 1926	258	36	1	295
New members added in fiscal year	81	10	1	92
Members reinstated	2			2
	341	46	2	389
Resigned and suspended for non-payment of dues	31	3		34
Paid up membership, May 28, 1927	310	43	2	355
Gain in fiscal year	52	7	1	60

Moved and seconded that report of secretary-treasurer be accepted. Carried.

Report of managing editor, C. G. Ferrari

REPORT OF THE MANAGING EDITOR

By Charles G. Ferrari

The financial statement of the journal "Cereal Chemistry" is embodied in the report of the secretary-treasurer. It should be pointed out that the fiscal year of the association and the journal do not coincide. Three numbers of the current volume have been issued, only two of which have been paid for and consequently the balance shown in favor of the journal will be drawn upon heavily in defraying expenses for the remainder of the year 1927. The funds available and in sight appear adequate.

Detailed statistics regarding the distribution of the journal have been compiled by the managing editor, who could not resist the epidemic of mathematical formulation which has overtaken us during the last year. The journal is mailed to 38 states, in the United States, and the distribution of domestic members, corporation members, and subscribers is indicated in an accompanying table. Of the total number, 424, there are 277 active members, 34 corporation members, and 113 subscribers. During the year a substantial number of former subscribers became members. The distribution of members, corporation members, and subscribers in foreign

countries is also tabulated. In 24 foreign countries there are 36 members, 9 corporation members, and 120 subscribers. The first five states ranked in the order of the greatest number of journal readers are, Minnesota 62, New York 51, Illinois 45, Missouri 44, and Kansas 41. Foreign distribution ranked in the same manner is: England 45, Canada 38, Germany 19, Holland 11, and Australia 10. These data have been scrutinized in a frantic attempt to deduce some correlations. There seems to be a tendency for subscribers to drift to membership. There is a distinct correlation between those who have paid their dues and subscriptions and those who receive the journal. The coefficient of correlation is plus one, very positive. The coefficient of correlation between those who have not paid their dues and subscriptions and those who do not receive the journal is likewise plus one, that is, plus one in the case of the association but minus the journal in the case of the delinquent. The standard deviation from this mean policy is zero, and is obtained by treating every one at least square. The probable error of this policy is zero.

It might be pointed out that the ratio of corporation members to active members in the United States is 1 to 81. The same ratio applied to foreign corporation members and foreign members is 1 to 4. The total mailing list this year is 26 less than it was at the same time last year. Membership, including corporation membership, has increased and the number of subscriptions has decreased. Advertising has decreased. To compensate for the loss of one regular advertiser the number of domestic subscribers must increase by 27, or the number of members by 36. Therefore, patronize your advertisers, and establish your identity with the journal.

On the basis of the expenditures for last year, if the members alone had to pay for the journal it would cost each one roughly $11.

The number of pages per volume of scientific material published has steadily increased since the journal was founded in 1924. The average number of pages per issue has been, for Volume I, 1924—60 pages; Volume II, 1925—68 pages; Volume III, 1926—72 pages. For the last fiscal year the six issues published contained 482 pages of scientific material, or an average of 80 pages per issue. This increase in size has occurred without any additional cost to members, and without the use of any larger fraction of their dues than was the case in 1924.

The managing editor has available for sale complete files of the journal beginning with Volume I, but the policy has been adopted of not selling certain issues singly, since the supply is nearly exhausted. In addition to unbound volumes, a supply of Volumes I and II bound together in blue library buckram are available for purchase. Members desiring to have "Cereal Chemistry" bound can arrange for the binding through the managing editor. Numerous requests have been received for loose-leaf binders such as were once advertised and supplied. These were discontinued long ago, but the regular buckram binding is no more expensive when two volumes are bound together.

DISTRIBUTION OF FOREIGN READERS

	Members		Subscribers	Total
	Active	Corporation		
Australia			10	10
Argentina	1		3	4
Belgium		1	1	2
Brazil			1	1
Canada	18	5	15	38
Cape Prov., So. Africa			1	1
Czechoslovakia	2			2
Denmark			2	2
England	9	3	33	45
France	1		2	3
Finland			1	1

DISTRIBUTION OF FOREIGN READERS—*Continued*

	Members			
	Active	Corporation	Subscribers	Total
Germany	3		16	19
Holland	1		10	11
Hungary			4	4
India			1	1
Italy			1	1
Japan			4	4
Natal, So. Africa			1	1
New Zealand	1			1
Norway			2	2
Russia			3	3
Spain			1	1
Sweden			8	8
Total, 23 countries	36	9	120	165

DISTRIBUTION OF DOMESTIC READERS

	Members			
	Active	Corporation	Subscribers	Total
Alabama	1			1
Arizona			1	1
Arkansas			1	1
California	7		7	14
Colorado	4	1	3	8
Georgia	1			1
Indiana	5		4	9
Illinois	32	3	10	45
Iowa	2		1	3
Kansas	36	3	2	41
Kentucky	2		1	3
Maryland	1		1	2
Massachusetts	1		1	2
Michigan	6	2	6	14
Minnesota	46	8	8	62
Mississippi	1			1
Missouri	31	5	8	44
Montana	4	1	5	10
Nebraska	11	1	2	14
New Jersey	2	1	1	4
New York	26	7	18	51
North Dakota	4		1	5
Ohio	5		4	9
Oregon	5		3	8
Oklahoma	3	1	3	7
Pennsylvania	4		8	12
Rhode Island	1			1
South Carolina			1	1
South Dakota			1	1
Tennessee	4			4
Texas	8	1		9
Utah	2		2	4
Virginia	3		2	5
Washington	7		3	10
Washington, D. C	7		2	9
West Virginia	1			1
Wisconsin	3		3	6
Wyoming	1			1
Total, 38 states	277	34	113	424

Moved and seconded that report be accepted. Carried.

Reports of committees

Report of employment committee, by C. B. Morison, who reported that 175 letters have been written, 7 men placed, 40 applicants are on list for positions. There seems to be a more optimistic expression on the part of those seeking employment.

Moved and seconded report be adopted. Carried.

Report of publicity committee, by L. R. Olsen. Mr. Olsen reports that a year ago 12 publications were on the list to receive our publicity material. This has been increased during the last year to 26. Most of these publications are sincerely appreciative and publish all material supplied them.

Moved and seconded report be adopted. Carried.

Report of question committee, by H. E. Weaver. Mr. Weaver reports that only one question has been referred to his committee during the year. This question was promptly answered.

Moved and seconded report be adopted. Carried.

Report of auditing committee

REPORT OF AUDITING COMMITTEE

We, the undersigned committee, have examined the books and accounts of the secretary-treasurer of this association and make the following comments.

We find that the records have apparently been very carefully kept, can find no errors, and take this occasion to compliment the secretary-treasurer upon the businesslike manner in which the accounts have been handled.

This committee is pleased to report that in our opinion the records as kept are correct and should be approved.

Signed:
R. Wallace Mitchell
Ralph B. Potts
Auditing Committee

Moved and seconded report be adopted. Carried.

Report of resolutions committee

REPORT OF RESOLUTIONS COMMITTEE

Omaha, Nebraska
June 1, 1927

WHEREAS, The American Association of Cereal Chemists, in session May 30 to June 3, 1927, at the Fontenelle Hotel, Omaha, Nebraska, recognizing that the success of this the thirteenth annual convention is due largely to the efforts of our president, R. J. Clark; our vice-president, L. R. Olsen; our secretary-treasurer, R. K. Durham; the program committee, and the local committee on arrangements, therefore

Be it resolved, that we express the appreciation of the association to Messrs. Clark, Olsen, Durham, Swanson, Potts, Herman, Collatz, Blish, Mize, Woosley, Fleming, and Rosse.

Be it further resolved, that we express our appreciation to the American Bakery Materials Co.; Central Scientific Co.; Despatch Oven Co.; Fleischmann Yeast Co.; Kansas City Laboratory Supply Co.; Laboratory Construction Co.; Maney Milling Co.; Nebraska Consolidated Mills Co.; Novadel Process Corp., Omaha Flour Mills Co.; Omaha Grain Exchange, Inc.; Provident Chemical Works; Red Star Yeast & Products Co.; Arthur A. Thomas Co.; Victor Chemical Works; The Weaver Co.; Wallace & Tiernan Co., Inc.; The Omaha Chamber of Commerce; Bemis Bros. Bag Co.; Carter Mayhew Co.; and the various firms that furnished the automobiles for our convenience in visiting the American Smelting and Refining Co.; and to this Company for allowing us to visit their plant; and also the management of the Fontenelle Hotel for their numerous efforts on our behalf.

Be it further resolved, that we extend our most cordial greetings to the Association of Operative Millers, the Millers' National Federation, The American Bakers Association and the American Society of Bakery Engineers, the Association of Official Agricultural Chemists, and express to them our sincere desire to cooperate with them in all matters pertaining to the general welfare and advancement of our common interests.

Be it resolved, that we express our sincere appreciation of the work of the editors of Cereal Chemistry, C. H. Bailey, Miss Alice McFeely, and C. G. Ferrari and our thanks for the service they have so efficiently rendered in the publication of Cereal Chemistry.

Be it further resolved, that this Association extend its thanks to the members of the various committees for their work in its behalf during the last year.

Be it also resolved, that our secretary be instructed to spread these resolutions upon the minutes of this convention, and to forward copies of the resolutions to those mentioned herein.

L. H. Bailey, Chairman,
Wm. L. Haley,
Fred J. Lumsden,
Resolutions Committee.

Moved and seconded report be adopted. Carried.

Election of officers

The following officers were elected:
President, L. R. Olsen
Vice-president, C. E. Mangels
Secretary-treasurer, R. K. Durham
Editor-in-chief, C. H. Bailey
Managing editor, C. G. Ferrari

New business: Moved by Schaal that Article 5, Section 2 be amended as follows: "The annual dues of this association shall be $7.00 per year, payable to the secretary-treasurer, of which $3.50 shall constitute a subscription to Cereal Chemistry and shall be set aside as such." Seconded.

Moved by Thompson that the amendment be amended to set aside $3.00 as subscription to Cereal Chemistry and that the executive committee be empowered to reallocate dues, giving Cereal Chemistry $3.50 if necessary. Seconded, lost.

Original amendment as proposed by A. A. Schaal carried.

Moved by Jones that Article 5, Section 1, be amended as follows: "Student applicants for membership who pass the entrance qualifications shall be admitted to membership upon payment of $7.00 to pay first year's dues, but all other applicants shall be charged an initiation fee of $3.00." Seconded, carried.

Moved by C. H. Bailey that Article 5, Section 2, be amended by striking out the last sentence and substituting, "Said dues shall be payable in advance and if not paid by March 1, said member shall be dropped from membership." Seconded, carried.

It was recommended by the executive committee that the association go on record as endorsing recommendation of President Clark that local sections of the association strengthen their local organizations and pattern them after the national association.

Recommended that the association endorse the proposals of President E. B. Price, of the American Society of Baking Engineers, and that the allied associations committee be instructed to take up the matter. Seconded, carried.

Moved and seconded that Article 6, Section 1, be amended as follows: "Meetings shall be held annually, at such time and place as may be determined by the convention assembled."

Moved and seconded that the amendment be amended to empower conventions to make recommendation to the executive committee and that this committee make final decision. Carried.

Original motion as amended lost.

Moved and seconded that members present at convention vote upon next annual meeting place and that city receiving largest number of votes be recommended to the executive committee, this committee to be governed accordingly in making final selection. Carried.

Invitations were presented and votes cast were as follows: Philadelphia, 0; Buffalo, 9; San Francisco, 3; Cleveland, 1; Memphis, 3; Minneapolis, 31; Toronto, 3; New Orleans, 0; Detroit, 0; Chicago, 10. Minneapolis received the largest number of votes.

Talk and message from the Association of Operative Millers, by honorary member M. F. Dillon, secretary of the A. O. M.

Meeting adjourned at 12:00 m.

Thursday, June 2

Meeting called to order at 9:10 a. m. by President Olsen

Report of methods committee by D. A. Coleman, Chairman

Moved by Potts that that portion of methods committee report referring to moisture be adopted. Seconded, carried.

Moved by Mitchell that report on protein be adopted. Seconded, carried.

Moved that report on ash be accepted. Seconded, carried.

Moved that report on glutenin be adopted. Seconded, carried.

Moved that report on hydrogen-ion determination be adopted. Seconded, carried.

Moved that report on flour sampling be adopted. Seconded, carried.

Paper—"Milling Temperatures and their Effect on Flour," by S. J. Lawellin

Paper—"Starch in Relation to Quality in Flour," by C. L. Alsberg

Meeting adjourned at 11:55 a. m.

Meeting called to order at 1:35 p. m. by President Olsen

Paper—"Cereal Products Other than Flour," by Carl Miner

Paper—"The Rôle of Phosphates in Bread Making," by R. A. Barackman and C. H. Bailey

Paper—"Value of the Viscosity Determination," by E. B. Working

Paper—"Grain Fumigation," by O. E. Gookins

Paper—"Shortenings Offered the Baking Trade," by A. A. Schaal

Report of committee on medal award, by C. L. Alsberg. The committee unanimously agreed that Thomas Burr Osborne be first recipient for his notable work on wheat protein, and that medal might appropriately be named the Thomas Burr Osborne medal. It was further agreed that the medal should be awarded only when meritorious work justifies, and may be on the basis of a single paper or series of papers. As a rule, it shall be awarded for published scientific work but shall not exclude those who have contributed to some worthy process which may be published only as a patent. Award will probably be more or less confined to the United States and Canada, altho this is not compulsory. Before making selection, committee will consult with prominent scientists in the field. Selections shall not be on a competitive basis. Moved and seconded report be adopted. Carried.

Paper—"A Critical Study of the Variability of the Hydrogen-ion Determination," by J. A. Dunn and C. H. Bailey

Meeting adjourned at 4:05 p. m.

Friday, June 3

Meeting called to order at 8:55 a. m. by President Olsen

Paper—"The Value of the Hydrogen-ion Concentration and Buffer Value Determination in the Testing and Use of Flours," by C. G. Harrel

Paper—"Yeast Food," by C. J. Patterson

Paper—"Enzymes in the Service of the Cereal Chemist," by S. Morgulis, Nebraska Medical College

Paper—"Surveying the New Wheat Crop," by R. C. Sherwood

Paper—"Preharvest Factors Which Affect Quality," by C. E. Mangels

Paper—"Value of Experimental Milling Tests," by R. S. Herman

Paper—"Effect of Severe Weathering on Certain Properties of Wheat," by W. O. Whitcomb and Arnold Johnson

Meeting adjourned at 11:55 a. m.

Meeting called to order at 2:10 p. m. by President Olsen

Moved by Mangels, chairman of executive committee, that in appreciation of our secretary's untiring efforts on behalf of the association, a gratuity of $100 be voted to him. Seconded, carried.

Executive committee reported that the committee sanctions the selection of Minneapolis as 1928 convention city.

Moved that president be authorized to send a telegram to the Association of Operative Millers, in convention at Dallas, urging that they select Minneapolis as 1928 convention city. Seconded, carried.

Moved that it be a sentiment of the association that next year a registration fee be charged which shall be large enough to cover banquet, luncheon, ladies entertainment, etc. Seconded, motion withdrawn.

Moved that this association leave with executive committee and advise the members to charge registration fee at annual convention which shall cover cost of banquet, and other entertainment, fee not to exceed $5.00. Seconded, carried.

Appointment of committees

Executive committee: C. E. Mangels, Chairman, R. W. Mitchell, H. E. Weaver, M. A. Gray

Committee on allied associations: H. E. Weaver, L. R. Olsen

Committee on methods of analysis: D. A. Coleman, Chairman, H. C. Fellows, C. B. Morison, C. W. Ingman, R. L. Frye

Committee on standardization of laboratory baking: M. J. Blish, Chairman, C. B. Morison, R. S. Herman, L. H. Bailey, Emily Grewe, L. D. Whiting, R. C. Sherwood, C. G. Harrel, R. M. Bohn

Committee on employment: C. B. Morison

Committee on convention program: C. H. Bailey, Chairman, C. O. Swanson, E. F. Tibbling, Paul Logue, F. W. Bliss

Committee on publicity: R. J. Clark, Chairman, S. J. Lawellin, W. C. Meyer

Question committee: S. J. Lawellin, Chairman, C. G. Harrel, A. W. Alcock, G. L. Alexander, A. D. Wilhoit

Membership committee: R. S. Herman, Chairman, W. L. Haley, A. A. Schaal, F. D. Patterson

Committee on medal award: C. L. Alsberg, Chairman, Paul Logue, Washington Platt, A. W. Alcock, R. A. Gortner

Local convention arrangements committee: M. A. Gray, Chairman

Paper—"Reduction of Excessive Routine in Laboratory Work," by M. A. Gray

Paper—"Possibilities of Research by Cereal Chemists," by Harry Weaver

Moved that committee be appointed to investigate the problems connected with soft wheat flours for cake production. Seconded, carried.

Discussion on the present and future of cereal chemists

Convention adjourned at 3:30 p. m.

REGISTRATION AT CONVENTION, OMAHA, NEBRASKA, MAY 30-JUNE 3, 1927

C. W. Ackerson, Agr. College, Univ. of Neb., Lincoln, Neb.
Howard Adler, Victor Chemical Works, Chicago, Ill.
F. W. Albro, Sperry Flour Co., Tacoma, Wash.
Geo. L. Alexander, Valier & Spies Mlg. Corp., St. Louis, Mo.
Carroll A. Armstrong, Igleheart Bros. Inc., Evansville, Ind.
C. L. Alsberg, Food Research Institute, Stanford University, Palo Alto, Calif.
Henry A. Baehr, Oklahoma Mill Co., Kingfisher, Okla.
C. H. Bailey, Univ. of Minn., St. Paul, Minn.
L. H. Bailey, Bureau of Chemistry, Washington, D. C.
J. C. Baker, Wallace & Tiernan Co., Montclair, N. J.
R. A. Barackman, Univ. of Minn., St. Paul, Minn.
W. L. Bergman, Industrial Appliance Co., Chicago, Ill.
M. J. Blish, Agr. College, Lincoln, Neb.
R. M. Bohn, W. E. Long Company, Chicago, Ill.
Mary Minton Brooke, Purity Bakeries Corp., Chicago, Ill.
Robert W. Brooks, The Fleischmann Co., New York, N. Y.
H. N. Clark, Blair Milling Co., Atchison, Kan.
Rowland J. Clark, Schultze Baking Co., Kansas City, Mo.
D. A. Coleman, Bur. of Agr. Economics, Washington, D. C.
F. A. Collatz, Washburn-Crosby Co., Minneapolis, Minn.
P. H. Crane, International Mlg. Co., Minneapolis, Minn.
Claude F. Davis, Western Star Milling Co., Salina, Kan.
G. A. Davis, Pillsbury Flour Mills Co., Atchison, Kan.
M. F. Dillon, Sec. Assocn. of Operative Millers, Kansas City, Mo.
J. M. Doty, Omaha Grain Exchange, Omaha, Neb.
J. A. Dunn, University of Minn., Minneapolis, Minn.
Otis B. Durbin, Purity Bakeries Corp., Chicago, Ill.
R. K. Durham, Rodney Mlg. Co., Kansas City, Mo.
Wm. G. Epstein, B. A. Eckhert Milling Co., Chicago, Ill.
Charles G. Ferrari, Univ. of Minn., Minneapolis, Minn.
R. M. Finch, Wallace & Tiernan Co., Inc., Minneapolis, Minn.
G. E. Findley, Arkansas City Mlg. Co., Arkansas City, Kan.
V. E. Fisher, Stanard Tiiton Mlg. Co., Alton, Ill.
H. J. Fleming, Neb. Consolidated Mlg. Co., Omaha, Neb.
T. G. Fletcher, Wichita Mill & Elev. Co., Wichita Falls, Texas.
Rolfe L. Frye, Kansas Flour Mills Corp., Kansas City, Mo.
J. M. Gillet, Victor Chemical Wks., Chicago, Ill.
W. E. Glasgow, Cargill Elev. Co., Minneapolis, Minn.
L. H. Goebel, Wallace & Tiernan Co., Newark, N. J.
R. A. Gortner, University of Minn., St. Paul, Minn.
Gertrude B. Gray, Purity Bakeries Corp. Chicago, Ill.
M. A. Gray, Pillsbury Flour Mills Co., Minneapolis, Minn.
Wm. L. Haley, Fisher Flour Mills Co., Seattle, Wash.
Wilbur Hanson, Lexington Mill & Elev. Co., Lexington, Neb.
S. E. Hardy, Charleston Mlg. & Produce Co., Charleston, W. Va.
C. G. Harrel, Bakeries Service Corp., New York, N. Y.
Raymond Hertwig, Hecker H-O Co., Buffalo, N. Y.
Geo. L. Howard, Moore-Lowry Flour Mills, Kansas City, Mo.
Bert D. Ingels, Wallace & Tiernan Co., Inc., Minneapolis, Minn.
Chas. W. Ingman, Minn. State Protein Lab., Minneapolis, Minn.
H. H. Johnson, Gooch Milling Co., Lincoln, Neb.
A. A. Jones, Hayland Flour Mills, Kansas City, Mo.
J. H. Julicher, Pillsbury Flour Mills Co., Buffalo, N. Y.
Ruth E. Larimor, Thomas Page Milling Co., Topeka, Kan.
S. J. Lawellin, Wallace & Tiernan Co., New Ulm, Minn.
L. E. Leatherock, Kansas Mlg. Co., Wichita, Kan.
John P. Lewis, Montana Grain Inspec. Lab., Bozeman, Mont.
Paul Logue, Provident Chemical Wks., St. Louis, Mo.
Omer W. Luff, Big Diamond Mills, Minneapolis, Minn.

Fred J. Lumsden, King Midas Milling Co., Minneapolis, Minn.
Elizabeth McKim, Bay State Milling Co., Winona, Minn.
Nell McNeil, Southwestern Lab., Kansas City, Mo.
C. E. Mangels, No. Dakota Agr. College, Fargo, No. Dak.
G. A. Marshall, Tacoma Grain Co., Tacoma, Wash.
R. H. Marts, Black Bros. Flour Mills, Beatrice, Neb.
Paul P. Merritt, Larabee Flour Mills Co., Kansas City, Mo.
A. W. Meyer, W. E. Long Co. Chicago, Ill.
W. C. Meyer, Ismert-Hincke Milling Co., Kansas City, Mo.
C. S. Miner, Miner Laboratories, Chicago, Ill.
H. S. Mitchell, Swift & Co., Chicago, Ill.
R. Wallace Mitchell, American Baking Material Company, Menomonie, Wis.
M. D. Mize, Omaha Grain Exchange, Omaha, Neb.
C. B. Morison, American Inst. Baking, Chicago, Ill.
C. T. Newell, Burrus Mill & Elev. Co., Fort Worth, Texas.
E. F. Olmstead, Gt. West Mill & Elev. Co., Amarillo, Texas.
Aksel G. Olsen, Postum Company, Inc., Battle Creek, Mich.
Leslie R. Olsen, International Milling Co., Minneapolis, Minn.
C. O. Oppen, Lawrenceburg Roller Mills, Lawrenceburg, Ind.
E. M. Paget, Rumford Chemical Wks., Chicago, Ill.
L. H. Patten, Jr., State Mill & Elevator, Grand Forks, No. Dak.
F. D. Patterson, Tex. Star Flour Mills, Galveston, Texas.
Hans Platenius, Agr. College, Univ. of Neb., Lincoln, Neb.
R. B. Potts, Wichita Flour Mills Co., Wichita, Kan.
Raymond Powers, Dunwoody Inst., Minneapolis, Minn.
Ludvig Reimers, Sperry Flour Co., Ogden, Utah.
W. A. Richards, International Milling Co., Minneapolis, Minn.
C. H. Robinson, Dominion Dept. Agr., Ottawa, Canada.
Hugo Roos, Modern Miller, Kansas City, Mo.
E. J. Rosse, Maney Milling Co., Omaha, Neb.
R. M. Sandstedt, Univ. of Neb., Lincoln, Neb.
T. W. Sanford, Eagle Roller Mill Co., New Ulm, Minn.
A. R. Sasse, Southwestern Milling Co., Kansas City, Mo.
A. A. Schaal, Biscuit & Cracker Mfrs. Assoen., Minneapolis, Minn.
Paul Sherrick, Central Scientific Co., Chicago, Ill.
R. C. Sherwood, Minnesota State Testing Mill, St. Paul, Minn.
F. P. Siebel, Jr., Siebel Inst. of Tech., Chicago, Ill.
H. J. Smith, Ralston-Purina Co., St. Louis, Mo.
M. R. Stanley, Victor Chemical Works, Chicago, Ill.
R. W. Stark, Ill. Agr. Exp. Station, Urbana, Ill.
M. L. Sudsberry, Novadel Process Corp., Buffalo, N. Y.
C. O. Swanson, Kan. State Agr. College, Manhattan, Kan.
G. Cullen Thomas, Washburn-Crosby Co., Minneapolis, Minn.
H. Lee Thompson, Crete Mills, Crete, Neb.
E. F. Tibbling, Washburn-Crosby Co., Kansas City, Mo.
Wm. M. Tinkham, Washburn-Crosby Milling Co., Minneapolis, Minn.
A. A. Towner, Red Star Milling Co., Wichita, Kan.
Alan E. Treloar, Univ. of Minn., Sydney, Australia.
H. F. Vaupel, El Reno Mill & Elev., El Reno, Okla.
M. R. Warren, Quaker Oats Co., Cedar Rapids, Iowa.
C. A. Weaver, Novadel Process Corp., Minneapolis, Minn.
H. E. Weaver, Flour Mills of America, Kansas City, Mo.
Lawrence D. Whiting, Ballard & Ballard Co., Louisville, Ky.
A. D. Wilhoit, A. D. Wilhoit Laboratory, Minneapolis, Minn.
Floyd Woosley, Omaha Flour Mills Co., Omaha, Neb.
E. L. Von Eschen, Bakeries Service Corp., Kansas City, Mo.

GUESTS

R. C. Abbott, Agr. College, Univ. of Neb., Lincoln, Neb.
Chas. Bennett, Omaha, Neb.
E. E. Bosin, Omaha Flour Mills Co., Omaha, Neb.
G. W. Bouskill, Grain Exchange, Omaha, Neb.
C. W. Brooks, Maney Milling Co., Omaha, Neb.
R. J. S. Carter, Carter Mayhew Mfg. Co., Minneapolis, Minn.
C. E. Cather, Wallace & Tiernan Co., Kansas City, Mo.
Lee E. Clark, K. S. Lab. Supply Co., Kansas City, Mo.
C. W. Detrick, Red Star Yeast & Prod. Co., Omaha, Neb.
Newton C. Evans, National Miller, Chicago, Ill.
H. L. Grapp, Despatch Oven Co., Minneapolis, Minn.
H. H. Hanneman, Millers National Fed., Minneapolis, Minn.
C. B. Hanson, International Milling Co., Omaha, Neb.
Rev. John A. Krance, Creighton University, Omaha, Neb.
R. K. Larmor, Univ. of Minn., St. Paul, Minn.
John L. Little, Creighton School of Med., Omaha, Neb.
J. J. Markey, The Rumford Co., Omaha, Neb.
J. H. Mayhew, Carter Mayhew Mfg. Co., Minneapolis, Minn.
Edgar S. Miller, Carrier Eng. Corp., Kansas City, Mo.
Sergius Morgulis, Univ. of Neb., Omaha, Neb.
J. A. Strang, Wallace & Tiernan Co., Kansas City, Mo.
Clarke R. Trimble, Puritan Mfg. & Supply Co., Omaha, Neb.
Reynier Van Evera, Reynier Van Evera Co., Kansas City, Mo.
Dean F. Worley, Bakeries Service Corp., Kansas City, Mo.

Mrs. C. H. Bailey, St. Paul, Minn.
Mrs. M. J. Blish, Lincoln, Neb.
Mrs. H. N. Clark, Atchison, Kan.
Mrs. Rowland J. Clark, Kansas City, Mo.
Mrs. Claude F. Davis, Salina, Kan.
Mrs. H. J. Fleming, Omaha, Neb.
Mrs. R. L. Frye, Kansas City, Kan.
Mrs. H. L. Grapp, Minneapolis, Minn.
Mrs. C. G. Harrel, New York, N. Y.
Mrs. A. A. Jones, Kansas City, Mo.
Mrs. R. K. Larmor, St. Paul, Minn.
Mrs. S. J. Lawellin, New Ulm, Minn.
Mrs. John P. Lewis, Bozeman, Mont.
Mrs. F. J. Lumsden, Minneapolis, Minn.
Mrs. R. Wallace Mitchell, Menomonie, Wis.
Mrs. M. D. Mize, Omaha, Neb.
Mrs. Aksel G. Olsen, Battle Creek, Mich.
Mrs. Leslie R. Olsen, Minneapolis, Minn.
Mrs. L. H. Patten, Grand Forks, So. Dak.
Mrs. R. C. Sherwood, St. Paul, Minn.
Mrs. C. O. Swanson, Manhattan, Kan.
Mrs. H. Lee Thompson, Crete, Neb.
Mrs. A. A. Towner, Wichita, Kan.
Mrs. H. F. Vaupel, El Reno, Okla.
Mrs. M. R. Warren, Cedar Rapids, Iowa.
Mrs H. E. Weaver, Kansas City, Mo.

INTERNATIONAL CONFERENCE ON FLOUR AND BREAD MANUFACTURE

The International Conference on Flour and Bread Manufacture, postponed last year, will be held in September, 1927, under the auspices of the Czechoslovakian government. The exact dates have not yet been announced. Dr. Jan Jelinek will serve as chairman, Ing. Francis Hruska as editor, and Dr. Karel Krtinsky as secretary.

Program

I. Opening of the Conference by the chairman of the Preparatory Committee

II. Reports on working the grain into flour
   1. Requirements of millers on grain quality
   2. Grain storage and its effect on grain quality
   3. Improving of grain quality
   4. Effect of individual milling processes on the quality and quantity of products

III. Reports on working flour into bread
   1. Requirements of bakers on flour quality
   2. Effects of flour storage on its quality
   3. Flour improving by means of (a) physical methods
      (b) chemical methods
   4. Effects of individual baking processes on the quality and quantity of bread and other baking products

IV. Reports of the consumption of milling and baking products
   1. Consumers' requirements on flour and bread quality
   2. Other different effects on the food value of flour and bread
   3. Effects of artificial flour improving on the food value of bread and on human health

V. Reports on the proposed unification
   1. Unified control methods for:
      a. raw materials
      b. control of the milling processes
      c. control of the baking processes
      d. control of the finished products
   2. Research work
   3. Schools
   4. Establishing of an international organization of cereal research workers; exchange of publications, collaboration of editors, arrangements for periodical international meetings, establishing of sections in all countries, and other topics

VI. Termination of the conference

VII. Special lectures on the best utilization of grain and flour with demonstrations of apparatus

VIII. Excursions and trips